TRUMBULL PUBLIC SCHOOLS
TRUMBULL, CONNECTICUT

Board of Education
Special Meeting - Virtual

Tuesday, February 27, 2024, 11:00 a.m.
AMENDED
Google Meet joining info
Video call link: https://meet.google.com/ryg-hikh-ydq
Or dial: (US) +1 413-489-4246 PIN: 243 432 728#

I. CALL TO ORDER

II. REPORTS/ACTION ITEMS

A. Approval/THS Music Department Trip to CMEA All-State Festival at Connecticut Convention Center

B. Approval/Trumbull High School Graduation Date

C. Approval/Middlebrook Elementary HVAC Improvements Project

TRUMBULL PUBLIC SCHOOLS
TRUMBULL, CONNECTICUT

Report to the Board of Education
Special Meeting–February 27, 2024

Mr. Joshua Murphy

Agenda Item – II-A

Approval of Trumbull High School Music Department to attend CMEA All-State Festival hosted at the CT Convention Center, Hartford, CT

The music department trip to the CMEA All-State Festival is scheduled for April 4, 2024 to April 6, 2024. Students have auditioned for and been accepted into this festival. Attendees are considered the highest achieving and talented music students in the state and will be afforded the opportunity to collaborate with other students of the same caliber from across the state.

Funding for this trip is provided through the students and families, and bus transportation is funded through the Music Department Account. Accordingly, please review the attached field trip request submitted by Trumbull High School teacher Joshua Murphy.

Recommendation

Approve the overnight THS Music Department trip to CMEA All-State Festival hosted at the CT Convention Center in Hartford, CT.

TRUMBULL PUBLIC SCHOOLS
APPLICATION FOR IN-STATE / OUT-OF-STATE / OVERNIGHT FIELD TRIP

Applications for field trips must be approved by principals and forwarded to the Assistant Superintendent at least thirty (30) days prior to date of trip for in-state day trips and at least ninety (90) days prior for out-of-state trips, overnight trips and trips to foreign countries.

Submitted By Joshua Murphy *Date Submitted* 2/9/2024

School THS *Group* THS Music Department

Date(s) of Trip 4/4/2024-4/6/2024 *Departure Date/Time* 8:00am 4/4 *Arrival Time at Destination* 9:00am 4/4

Leave Time from Destination _____ *Arrival Time Back at School* _____ *BOE Approval Yes* X *No* ___

Destination CMEA All-State Festival hosted at the Connecticut Convention Center

Destination Address 100 Columbus Blvd *City* Hartford *State* CT *Zip* 06103

How will this activity enhance student learning and integrate curricular goals?
Students have auditioned and been accepted into this festival. Attendees are considered the highest achieving and talented music students in the state and will be afforded the opportunity to collaborate with other students of the same caliber from across the state.

PLEASE ATTACH ITINERARY AND / OR ANY OFFICIAL SITE PAPERWORK THAT DETAILS THE EXPERIENCE

No. of Students 8 Grade Level 9-12 No. of Chaperones ___ No. of Teachers 2

Student : Teacher/Chaperone Ratio
In-state day trip: PK to Gr 5 – 5:1 Gr 6-8 – 10:1 Gr 9-12 – 15:1
Out-of-state, out-of-country, overnight trip: All grades: 10:1

Names of Teachers Attending	Cell Phone	Subs? (Y / N)	Dates for Subs	Names of Subs (if known)
Josh Murphy	860-331-6365	Y	4/4-4/5	
Chris Wasko	646-708-2840	Y	4/4-4/5	

Nurse Notified E. Sullivan Signature Date 2/9/24

COST AND FINANCING	Totals	To Be Paid By	PO/Acct. No.	Additional Notes
Total Anticipated Cost of Trip				
• Transportation	$150	Music Acct.	02400830	
• Registration Fees	$			
• Other	$			
Student Contributions				
• Transportation	$			
• Entrance Fees / Room & Board / Food	$425	Students		Cost set by CMEA
TOTAL COST TO EACH STUDENT	$425			

Transportation by: Bus X Coach ___ Van ___ Parents' Cars ___ (Parents must sign parent driver form)
Other _____

***If school / coach buses are involved, this request will be forwarded to the Transportation Department.**

Principal/Dept. Head Signature _____ Date 2/9/24

Assistant Superintendent Signature _____ Date 2/12/24

Superintendent Signature _____ Date _____
For overnight and international field trips

RECEIVED
for approval
FEB 14 2024

TRUMBULL HIGH SCHOOL
PRINCIPAL'S OFFICE

Date: February 9, 2024

To: Dr. Iwanicki

From: Todd Manuel

Re: Field Trip Waiver

Dr. Iwanicki,

I am submitting a 90-day waiver request for the following:

Joshua Murphy – out of state – 4/4/24 – 4/6/24, THS Music Department to attend the CMEA All-State Festival, CT Convention Center, Hartford, CT.

Per Mr. Murphy, "The auditions for the Connecticut Music Educators Association All-State Festival were held on Saturday, February 3, 2024. The list of students who were granted acceptance into the festival was released late on Thursday evening, February 8, 2024. We did not know definitively if any students would be attending the trip until that time".

Thank you.

TRUMBULL PUBLIC SCHOOLS
TRUMBULL, CONNECTICUT

Report to the Board of Education
Special Meeting – February 27, 2024 Dr. Semmel

Agenda Item – II – B Approval/Graduation Date, Class of 2024

Dr. Semmel will present the Trumbull High School Graduation date for the Class of 2024 for Monday, June 10, 2024.

Administrative Recommendation: Approve Trumbull High School Graduation Date.

TRUMBULL PUBLIC SCHOOLS
TRUMBULL, CONNECTICUT

Report to the Board of Education
Special Meeting – February 27, 2024

Mr. David P. Cote, P.E.

Agenda Item II-C

Middlebrook Elementary HVAC Improvements Project: The attached drawings, specifications and cost estimate require Board of Education approval as per the Department of School Construction of the Connecticut State Department of Education.

Recommendation:

The Board of Education to approve the Final Drawings, Specifications and Cost Estimate for the Middlebrook Elementary HVAC Improvements Project.

PROJECT TITLE:

TOWN OF TRUMBULL - MIDDLEBROOK ELEMENTARY SCHOOL

FACILITIES HVAC UPGRADE

220 MIDDLEBROOK AVENUE
TRUMBULL, CONNECTICUT 06611

PROJECT LOCATION:



SILVER PETRUCELLI + ASSOCIATES

3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

100% CONSTRUCTION DOCUMENTS: 02/09/2024

TOWN OFFICIALS

BUILDING OFFICIAL:

FIRE MARSHAL:

HEALTH OFFICIAL:

ADA/504 OFFICER:

DRAWING LIST

COVER SHEET

GENERAL INFORMATION:
G100 GENERAL & CODE INFORMATION

CIVIL:
C100 PARTIAL SITE PLAN

ARCHITECTURAL:
A001 BUILDING "B" DEMOLITION PLANS
A100 BUILDING "B" FLOOR PLANS & DETAILS
A200 BUILDING "B" REFLECTED CEILING PLANS

FIRE PROTECTION:
FP001 GENERAL NOTES
FP110 BUILDING "B" FIRST & SECOND PARTIAL FLOOR PLANS
FP201 SCHEDULES & DETAILS

PLUMBING:
P001 GENERAL NOTES
P110 BASEMENT/GROUND FLOOR PLANS
P111 BUILDING "B" FIRST & SECOND PARTIAL FLOOR PLANS
P112 ROOF PLAN
P201 SCHEDULES & DETAILS

MECHANICAL:
M001 NOTES, LEGENDS & ABBREVIATIONS
M010 BUILDING "B" FIRST & SECOND FLOOR DEMOLITION PLANS
M011 BUILDING "B" ROOF DEMOLITION PLAN
M110 BUILDING "B" FIRST & SECOND FLOOR PLANS
M111 BUILDING "B" ROOF PLAN
M201 DETAILS
M202 DETAILS
M301 SCHEDULES
M302 SCHEDULES
M303 SCHEDULES
M401 VRF SYSTEM DIAGRAMS
M402 VRF SYSTEM DIAGRAMS

ELECTRICAL:
E001 SYMBOLS, NOTES & ABBREVIATIONS
E010 BUILDING "B" FIRST & SECOND FLOOR DEMOLITION PLANS
E011 BUILDING "B" ROOF & BASEMENT FLOOR DEMOLITION PLANS
E110 BUILDING "B" FIRST & SECOND FLOOR POWER PLANS
E111 BUILDING "B" ROOF & BASEMENT FLOOR POWER PLANS
E210 BUILDING "B" FIRST & SECOND FLOOR LIGHTING PLANS
E210A BUILDING "B" FIRST & SECOND FLOOR "ALTERNATE" LIGHTING PLANS
E301 PARTIAL SITE PLAN
E401 ONE LINE RISER DIAGRAM
E501 LIGHT FIXTURE & PANEL BOARD SCHEDULES
E601 DETAILS
E602 DETAILS

ARCHITECT
SILVER PETRUCELLI + ASSOCIATES
3190 WHITNEY AVENUE, HAMDEN CT 06518
311 STATE STREET NEW LONDON, CT 06320
PHONE 203 230 9007 silverpetrucelli.com

NOT FOR CONSTRUCTION

NOT FOR CONSTRUCTION

M/E/P/FP ENGINEERS
SILVER PETRUCELLI + ASSOCIATES
3190 WHITNEY AVENUE, HAMDEN CT 06518
311 STATE STREET NEW LONDON, CT 06320
PHONE 203 230 9007 silverpetrucelli.com

NOT FOR CONSTRUCTION

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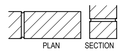
STATE PROJECT #144-_____

ARCHITECTURAL ABBREVIATIONS

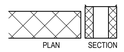
A.B.	ANCHOR BOLT
A.C.P.	ASBESTOS CEMENT PIPE
ADJ.	ADJUSTABLE
A.F.F.	ABOVE FINISH FLOOR
AC.T.	ACOUSTICAL CEILING TILE
ALUM.	ALUMINUM
APPROX.	APPROXIMATE
ARCH.	ARCHITECTURAL
ASPH.	ASPHALT
AVG.	AVERAGE
BSMT.	BASEMENT
BD.	BOARD
BRG.	BEARING
BRK.	BRICK
BIT.	BITUMINOUS
BLK.	BLOCK
BLDG.	BUILDING
B.S.	BOTH SIDES
C.B.	CATCH BASIN
C.B.R.	CATCH BASIN TO BE REMOVED
C.I.	CAST IRON
C.I.P.	CAST IN PLACE CONCRETE
CLG.	CEILING
℄	CENTER LINE
C. BD.	CHALK BOARD
C.O.	CLEAN OUT
COL.	COLUMN
CONC.	CONCRETE
C.M.U.	CONCRETE MASONRY UNIT
CONF.	CONFERENCE
CONSTR.	CONSTRUCTION
CONT.	CONTINUOUS, CONTINUE
C.J.	CONTROL/CONSTRUCTION JOINT
CONTR.	CONTRACTOR
C.C.	CURB CUT
DET.	DETAIL
DIA.	DIAMETER
DIM.	DIMENSION
DR.	DOOR
DN.	DOWN
DWG.	DRAWING
E	ELECTRICAL
EA.	EACH
ECTR.	EXISTING CEILING TO REMAIN
ED.	EDUCATION
ELEC.	ELECTRICAL
E.F.	EACH FACE
E.J.	EXPANSION JOINT
EL.	ELEVATION
ELEV.	ELEVATION
EMER.	EMERGENCY
ENCL.	ENCLOSURE
ENL.	ENLARGED
ENT.	ENTRANCE
EP.	EPOXY PAINT
EQ.	EQUAL
ES.	EXPOSED STRUCTURE
E.T.R.	EXISTING TO REMAIN
E.W.	EACH WAY
E.W./E.F.	EACH WAY/EACH FACE
EXAM.	EXAMINATION
EXIST.	EXISTING
EXP.	EXPANSION
EXT.	EXTERIOR
FDN.	FOUNDATION
F.F.	FINISHED FLOOR
F.P.	FOLDING PARTITION
FIN.	FINISH, FINISHED
FIXT.	FIXTURE
FL.	FLOOR
FT.	FOOT
F.S.	FAR SIDE
FTG.	FOOTING
G	GAS
GA.	GAGE, GAUGE
GEN.	GENERAL
G.C.	GENERAL CONTRACTOR
GYP.	GYPSUM
GYP. BD.	GYPSUM BOARD
H.C.	HANDICAPPED
HD.	HEADED
HDWR.	HARDWARE
HGT.	HEIGHT
H.P.	HIGH POINT
H.M.	HOLLOW METAL
HORIZ.	HORIZONTAL, HORIZONTALLY
H.B.	HOSE BIBB
HR.	HOUR
HYD.	HYDRANT
INSUL.	INSULATION, INSULATED
INT.	INTERIOR
INV.	INVERT
JAN.	JANITOR
K.P.	KICK PLATE

LAM.	LAMINATE
L.F.	LINEAL FOOT
LG.	LONG
LOC.	LOCATION
L.P.	LOW POINT
LTG.	LIGHTING
LVL.	LEVEL
M	MINUTE
MAS.	MASONRY
MAX.	MAXIMUM
MECH.	MECHANICAL
M.H.	MANHOLE
MIN.	MINIMUM
MISC.	MISCELLANEOUS
M.O.	MASONRY OPENING
MTD.	MOUNTED
MTL.	METAL
N.A.	NOT APPLICABLE
N.I.C.	NOT IN CONTRACT
NO.	NUMBER
NOM.	NOMINAL
N.P.S.	NOMINAL PIPE SIZE
N.S.	NEAR SIDE
N.T.S.	NOT TO SCALE
O.C.	ON CENTER
O.C.C.	OCCUPANT
O.D.	OUTSIDE DIAMETER
OPNG.	OPENING
P.C.B.	PAINTED CONCRETE BLOCK
P.G.B.	PAINTED GYPSUM BOARD
PL.	PLATE
PLUMB.	PLUMBING
PLYWD.	PLYWOOD
PREP.	PREPARATION
P.T.	PRESSURE TREATED
PTD.	PAINTED
P.V.C.	POLYVINYL CHLORIDE
R.	RISER
RAD.	RADIUS
R.C.P.	REINFORCED CONCRETE PIPE
R.D.	ROOF DRAIN
REINF.	REINFORCEMENT
REQ'D.	REQUIRED
R.H.	ROOF HATCH
R.L.	ROOF LEADER
RM.	ROOM
S.	STORM
SAN.	SANITARY
S.C.	SEALED CONCRETE
SCHED.	SCHEDULE
SECT.	SECTION
S.F.	STEP FOOTING
SIM.	SIMILAR
S.O.G.	SLAB ON GRADE
SPEC.	SPECIFICATIONS
SQ.	SQUARE
SQ. FT.	SQUARE FEET
STL.	STEEL
STRUCT.	STRUCTURAL
SUSP.	SUSPENDED, SUSPENSION
S.W.	SHEAR WALL
S.W.F.	SHEAR WALL FOOTING
SYS., SYST.	SYSTEM
T.	TELEPHONE
T&B	TOP & BOTTOM
TECH.	TECHNOLOGY
T.O.	TOP OF
T.O.F.	TOP OF FRAME
T.O.S.	TOP OF STEEL
T/S.	TOP OF SLAB
T/W	TOP OF WALL
T.T.F.	TRIM TO FIT
TYP.	TYPICAL
U.O.N.	UNLESS OTHERWISE NOTED
V.B.	VINYL BASE
V.C.T.	VINYL COMPOSITE TILE
VERT.	VERTICAL
V.I.F.	VERIFY IN FIELD
W.	WATER
W/	WITH
WCJ	WALL CONTROL JOINT
WD.	WOOD
WF.	WIDE FLANGE
WNDW.	WINDOW
W.W.F.	WELDED WIRE FABRIC
W.W.M.	WELDED WIRE MESH
@	AT
℄	DIAMETER

MATERIAL CONVENTIONS



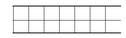
BRICK

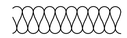


CONCRETE MASONRY UNIT (CMU)


CONCRETE (CAST-IN-PLACE)


CONCRETE (PRE-CAST)


RIGID BOARD INSULATION


INSULATION (BATT)


EARTH

GYPSUM BOARD


PLYWOOD

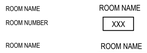

WOOD FRAMING (THRU MEMBER)


WD FRAMING (UNINTERRUPTED MEMBER)


WD TRIM/FINISH


ACOUSTICAL TILE OR PANEL

GRAPHIC SYMBOLS



ROOM IDENTIFICATION



CEILING PLAN
ROOM IDENTIFICATION



FINISH FLOOR PLAN
ROOM IDENTIFICATION



CASEWORK SYMBOL



EQUIPMENT SYMBOL



DOOR NUMBER



DEMOLITION NOTE



WINDOW TYPE



DETAIL NUMBER
DRAWING NUMBER



CONSTRUCTION NOTE



SECTION/DETAIL
DRAWING NUMBER



BUILDING SECTION
DRAWING NUMBER



WALL SECTION
DRAWING NUMBER



EXTERIOR ELEVATION
DRAWING NUMBER



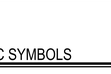
"#" INTERIOR ELEVATION
"XX" DRAWING NUMBER



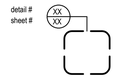
WALL TYPE



REVISION MARK



COLUMNS (EXISTING)

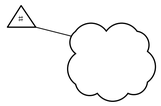


DETAIL CALL OUT



ELEVATION MARKER


DATUM POINT



REVISION CLOUD

GENERAL NOTES

1. CONTRACTOR IS RESPONSIBLE TO FIELD VERIFY ALL EXIST. CONDITIONS & DIMENSIONS PRIOR TO CONSTRUCTION.
2. CONTRACTOR IS RESPONSIBLE TO REPAIR OR REPLACE ANY AREAS DAMAGED OUTSIDE THE SCOPE OF WORK RETURNING THEM TO THEIR ORIGINAL CONDITION AT NO EXPENSE TO THE OWNER.
3. PATCH ALL EXIST. MATERIALS AFFECTED BY NEW CONSTRUCTION IN THIS PROJECT (MATCH EXISTING).
4. ALL MATERIALS & EQUIPMENT ARE NEW UNLESS OTHERWISE NOTED AS "EXISTING".
5. REMOVE ALL DEMOLISHED MATERIALS FROM SITE. LEAVE SITE CLEAN OF ALL CONSTRUCTION DUST & DEBRIS AT THE END OF EACH DAY. CONTRACTOR WILL BE RESPONSIBLE FOR ALL CUSTODIAL TIME ASSOCIATED WITH CLEANING NOT PERFORMED BY CONTRACTOR.
6. CONTRACTOR IS RESPONSIBLE FOR REMOVING, RELOCATING & RECONNECTING ANY & ALL ELECTRONIC EQUIPMENT, DEVICES, CONDUIT, SECURITY &/OR WIRING AFFECTED BY THE SCOPE OF WORK PRIOR TO DEMOLITION & UPON COMPLETION OF CONSTRUCTION CONTRACTOR TO VERIFY ALL ASSOCIATED COMPONENTS AFFECTED WITH ARCHITECT & OWNER.
7. CONTRACTOR IS RESPONSIBLE TO SURVEY & DOCUMENT ALL LOCATIONS OF INTERIOR SCOPE OF WORK PRIOR TO BID. CONTRACTOR IS RESPONSIBLE TO CARRY ALL TRADES IN BID REQUIRED TO REMOVE/REINSTALL ALL CONDITIONS AFFECTED BY SCOPE OF WORK.
8. ANY DEMOLITION/CONSTRUCTION ACTIVITY WHICH WOULD IMPACT LEAD, ASBESTOS &/OR OTHER (TOXIC/NON-TOXIC) MUST BE CONDUCTED WITHIN COMPLIANCE & CODE REQUIREMENTS. (SEE PROJECT MANUAL FOR ADDITIONAL INFO.)
9. ALL DIMENSIONS ARE TO OUTSIDE FACE OF GYPSUM WALLBOARD & MASONRY.

CODE INFORMATION

1. PROJECT DESCRIPTION:

   HVAC UPGRADES.

   SCOPE OF WORK INCLUDES UPGRADES TO EXISTING MECHANICAL SYSTEMS WITH ASSOCIATED ARCHITECTURAL, ELECTRICAL, FIRE PROTECTION, PLUMBING, AND CIVIL DETAILS.

2. CLASSIFICATION OF WORK:

   LEVEL TWO (2) ALTERATION

DATE OF ORIGINAL CONSTRUCTION	1951
DATE OF CURRENT CONSTRUCTION	2024

3. APPLICABLE BUILDING CODES:

- CONNECTICUT STATE BUILDING CODE (2021 ICC)	2022
- CONNECTICUT STATE FIRE PREVENTION CODE	2022
- INTERNATIONAL EXISTING BUILDING CODE	2021
- INTERNATIONAL BUILDING CODE	2021
- INTERNATIONAL MECHANICAL CODE	2021
- INTERNATIONAL PLUMBING CODE	2021
- INTERNATIONAL ENERGY CONSERVATION CODE	2021
- NATIONAL ELECTRIC CODE (NFPA 70)	2020
- ICC A117.1 ACCESSIBLE & USEABLE BLDGS./FACILITIES	2017

- ALL CODE SECTION REFERENCES ARE TO BE CSBC UNLESS OTHERWISE NOTED

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES

3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

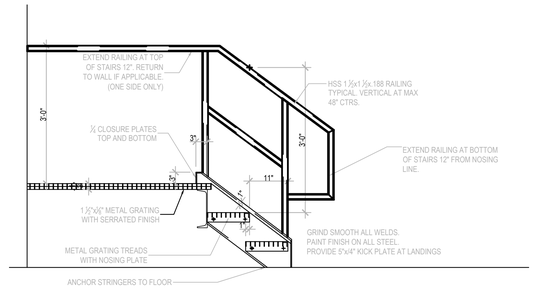
Drawing Title:

GENERAL & CODE INFORMATION

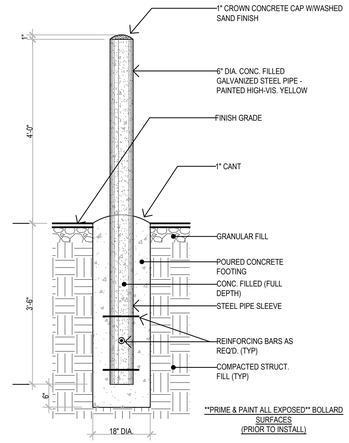
State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: MCM
Project Number: 22.335

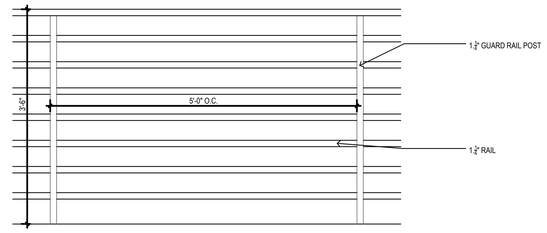
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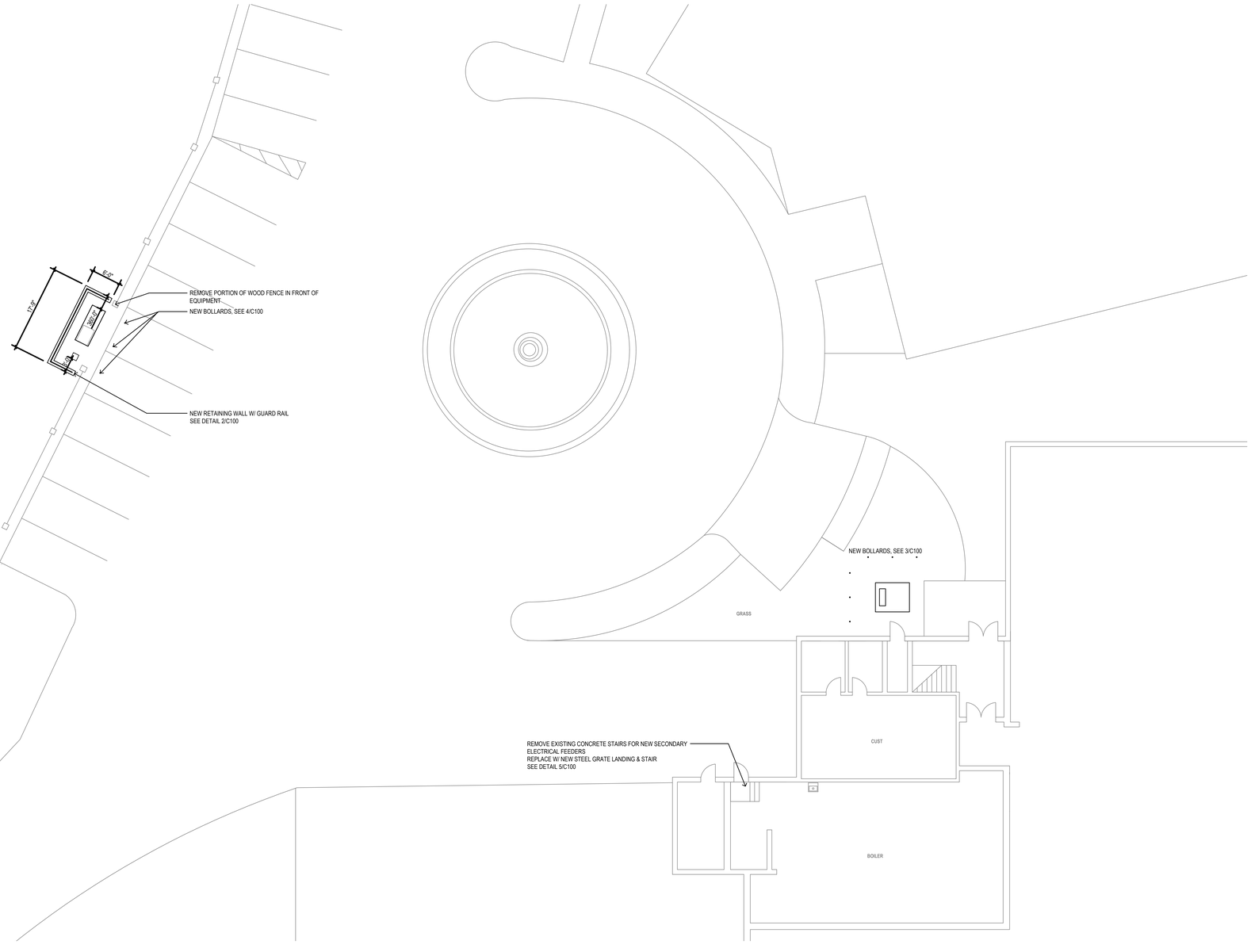
5 STEEL GRATE STAIR DETAIL
SCALE: 1" = 1'-0"



4 BOLLARD DETAIL
SCALE: 1" = 1'-0"

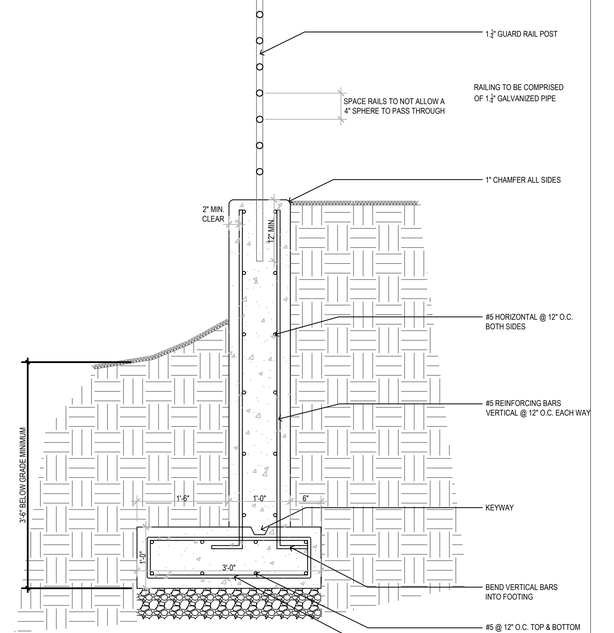


3 PIPE RAILING DETAIL
SCALE: 1" = 1'-0"



1 SITE PLAN
SCALE: 1" = 10'-0"

NORTH



2 RETAINING WALL DETAIL
SCALE: 1" = 1'-0"

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES
3190 WHITNEY AVENUE HAMDEN CT 06518
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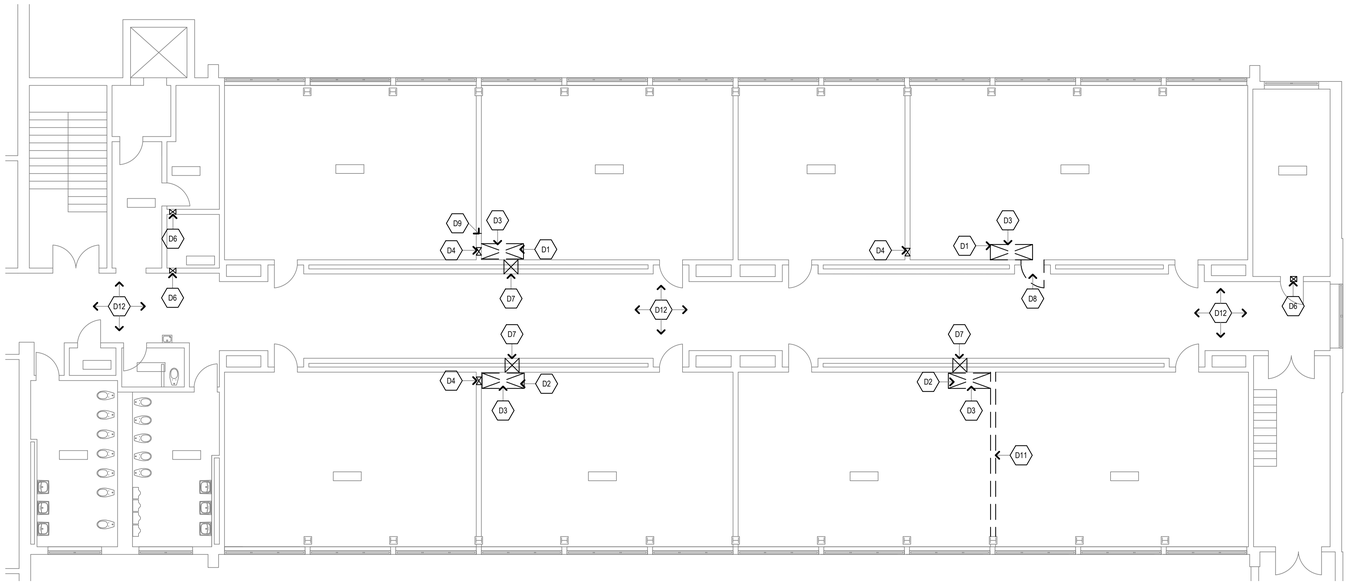
Revision:	Description:	Date:	Revised By:

Drawing Title:
PARTIAL SITE PLAN

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: MCM
Project Number: 22.335

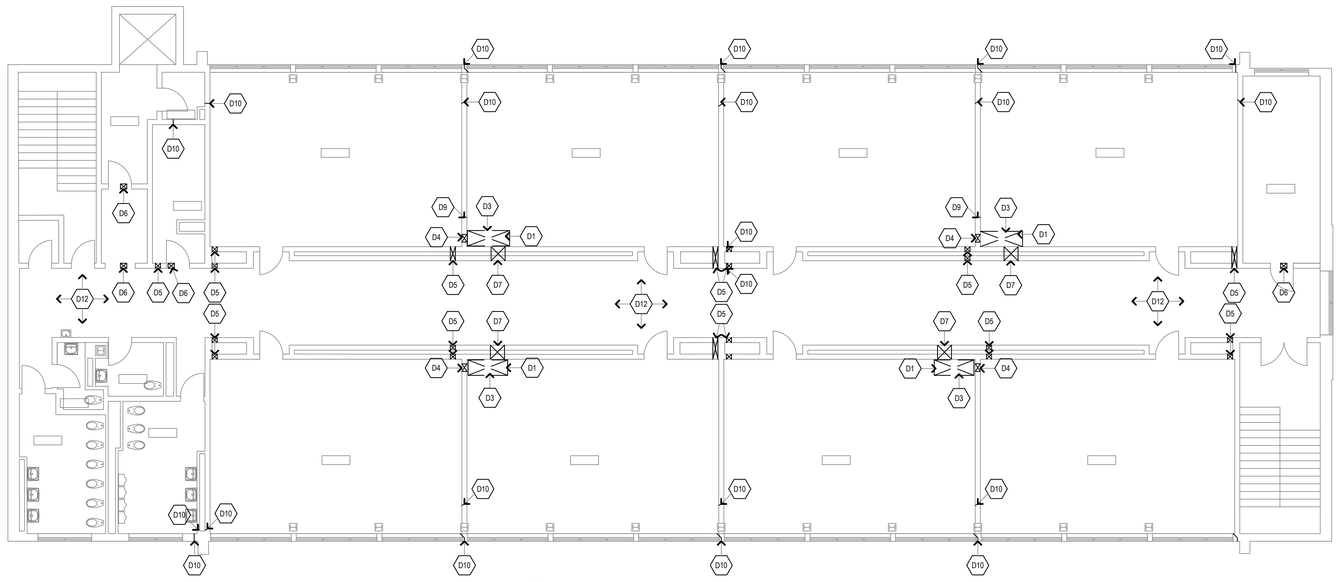
Drawing Number: C100



1 BUILDING 'B' FIRST FLOOR DEMOLITION PLAN

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

NORTH



2 BUILDING 'B' SECOND FLOOR DEMOLITION PLAN

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

NORTH

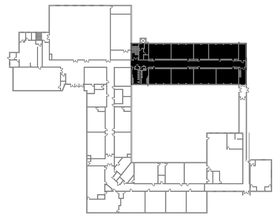
GENERAL NOTES

1.	CONTRACTOR IS RESPONSIBLE TO FIELD VERIFY ALL EXIST. CONDITIONS & DIMENSIONS PRIOR TO CONSTRUCTION.
2.	CONTRACTOR IS RESPONSIBLE TO REPAIR OR REPLACE ANY AREAS DAMAGED OUTSIDE THE SCOPE OF WORK RETURNING THEM TO THEIR ORIGINAL CONDITION AT NO EXPENSE TO THE OWNER.
3.	PATCH ALL EXIST. MATERIALS AFFECTED BY NEW CONSTRUCTION IN THIS PROJECT (MATCH EXISTING).
4.	ALL MATERIALS & EQUIPMENT ARE NEW UNLESS OTHERWISE NOTED AS "EXISTING".
5.	REMOVE ALL DEMOLISHED MATERIALS FROM SITE. LEAVE SITE CLEAN OF ALL CONSTRUCTION DUST & DEBRIS AT THE END OF EACH DAY. CONTRACTOR WILL BE RESPONSIBLE FOR ALL CUSTODIAL TIME ASSOCIATED WITH CLEANING NOT PERFORMED BY CONTRACTOR.
6.	CONTRACTOR IS RESPONSIBLE FOR REMOVING, RELOCATING & RECONNECTING ANY & ALL ELECTRONIC EQUIPMENT, DEVICES, CONDUIT, SECURITY &/OR WIRING AFFECTED BY THE SCOPE OF WORK PRIOR TO DEMOLITION & UPON COMPLETION OF CONSTRUCTION CONTRACTOR TO VERIFY ALL ASSOCIATED COMPONENTS AFFECTED WITH ARCHITECT & OWNER.
7.	CONTRACTOR IS RESPONSIBLE TO SURVEY & DOCUMENT ALL LOCATIONS OF INTERIOR SCOPE OF WORK PRIOR TO BID. CONTRACTOR IS RESPONSIBLE TO CARRY ALL TRADES IN BID REQUIRED TO REMOVE/REINSTALL ALL CONDITIONS AFFECTED BY SCOPE OF WORK.
8.	ANY DEMOLITION/CONSTRUCTION ACTIVITY WHICH WOULD IMPACT LEAD, ASBESTOS &/OR OTHER (TOXIC/NON-TOXIC) MUST BE CONDUCTED WITHIN COMPLIANCE & CODE REQUIREMENTS. (SEE PROJECT MANUAL FOR ADDITIONAL INFO.)
9.	ALL DIMENSIONS ARE TO OUTSIDE FACE OF GYPSUM WALLBOARD & MASONRY.

DEMOLITION NOTES

DX

1.	REMOVE AREA OF EXISTING CONCRETE FLOOR ASSEMBLY & ASSOCIATED REINFORCEMENT, FINISHES & COMPONENTS. REFER TO A100 FOR SIZING.
-	REINFORCE AS REQUIRED
2.	REMOVE EXISTING CEILING CHASE.
-	REMOVE FRAMING, GYPSUM/PLASTER ASSEMBLY & ASSOCIATED FINISHES.
3.	REMOVE CEILING GRID & TILES AS NEEDED TO CONSTRUCT SHAFT ENCLOSURE.
4.	REMOVE 12"x12" PORTION OF WALL FOR RETURN AIR DUCT GRILLE.
5.	REMOVE 6"x4" PORTION OF WALL FOR REFRIGERANT LINES.
6.	REMOVE 10"x8" PORTION OF WALL FOR NEW REGISTERS.
7.	REMOVE 22"x14" PORTION OF WALL FOR SUPPLY DUCT.
8.	REMOVE EXISTING DOOR, HARDWARE & TRIM.
9.	PROVIDE 4" DIAMETER HOLE FOR SPRINKLER PIPING, REFER TO FIRE PROTECTION PLANS.
10.	PROVIDE 3" DIAMETER HOLE FOR PLUMBING PIPING, REFER TO PLUMBING PLANS.
11.	REMOVE WALL PARTITION, PREPARE FOR NEW CMU WALL.
12.	REMOVE EXISTING CORRIDOR CEILING TILES & GRID.



NORTH

KEY PLAN

SCALE: NONE

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES

3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

Drawing Title:

BUILDING "B"
DEMOLITION PLANS

State Project #144-_ _ _ _ _ _

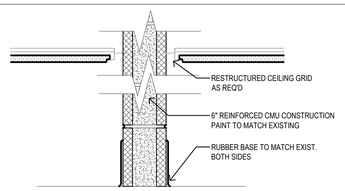
Date: 2-09-2024

Scale: AS NOTED

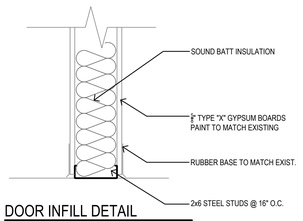
Drawn By: MCM

Project Number: 22.335

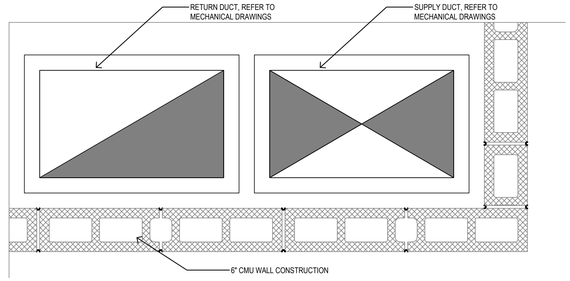
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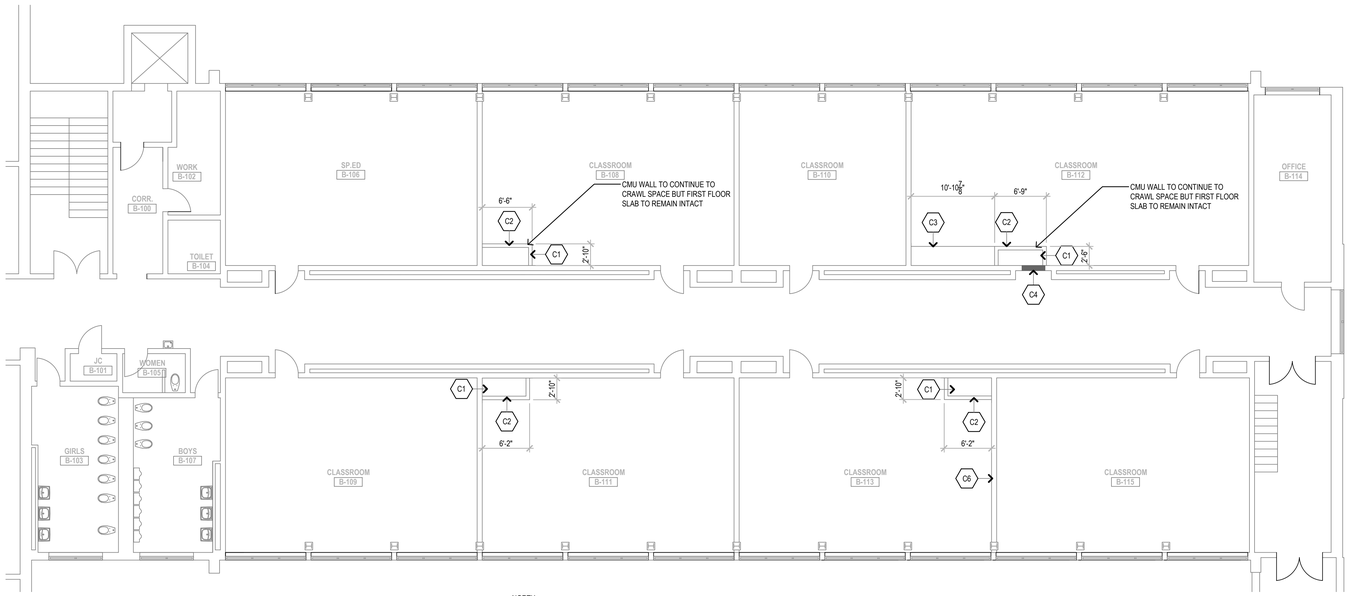
8 NEW CLASSROOM PARTITION DETAIL
SCALE: 1.1/2" = 1'-0"



7 DOOR INFILL DETAIL
SCALE: 1.1/2" = 1'-0"

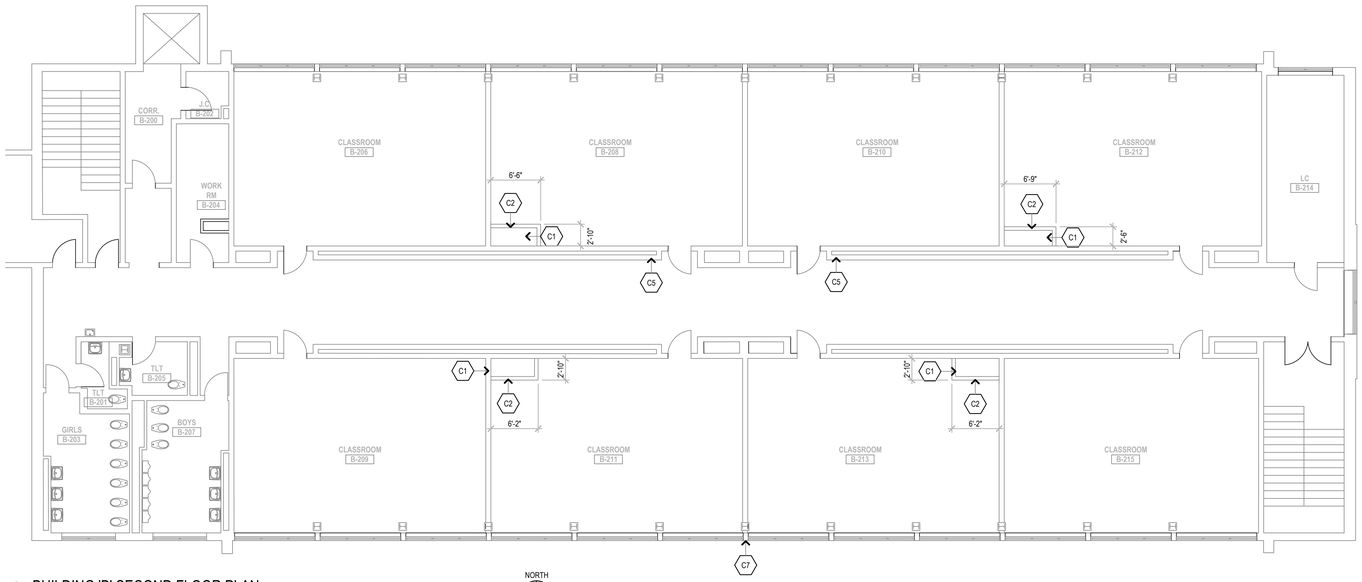


6 1-HOUR RATED SHAFT ENCLOSURE PLAN DETAIL
SCALE: 1.1/2" = 1'-0"



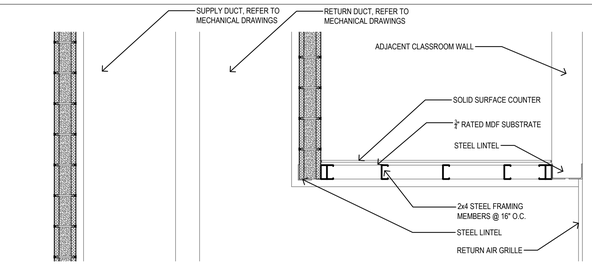
1 BUILDING 'B' FIRST FLOOR PLAN
SCALE: 1/8" = 1'-0"

NORTH

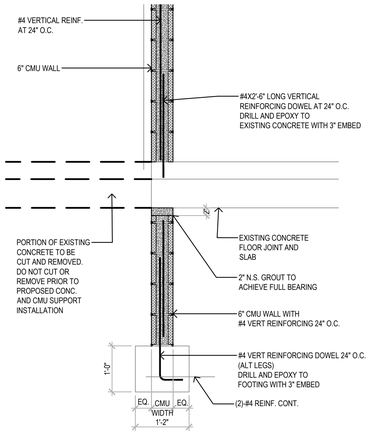


2 BUILDING 'B' SECOND FLOOR PLAN
SCALE: 1/8" = 1'-0"

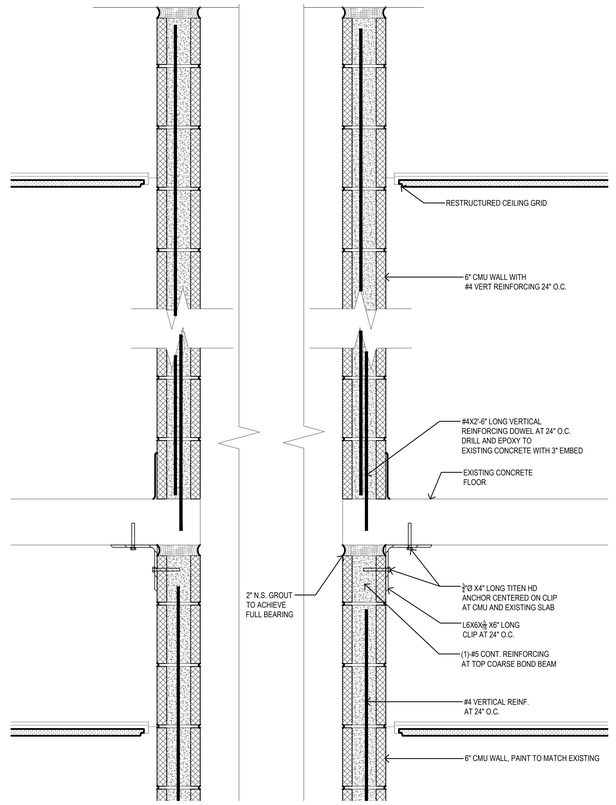
NORTH



5 HORIZONTAL CHASE COUNTER DETAIL
SCALE: 3/4" = 1'-0"



4 FOOTING DETAIL
SCALE: 1.1/2" = 1'-0"



3 1-HOUR RATED SHAFT ENCLOSURE DETAIL
SCALE: 1.1/2" = 1'-0"

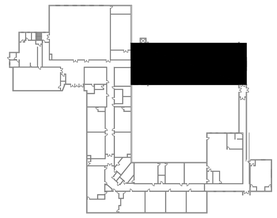
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CONSTRUCTION NOTES

CX

1. CONSTRUCT NEW 1-HOUR RATED SHAFT ENCLOSURE FOR DUCTWORK. SEE DETAIL 3/A100.
2. RESTRUCTURE CEILING GRID AROUND NEW SHAFT ENCLOSURE.
3. CONSTRUCT NEW HORIZONTAL CHASE AT FLOOR LEVEL, TOP WITH SOLID SURFACE COUNTER TO CREATE NEW WORKSPACE.
4. INFILL DOOR OPENING WITH METAL STUDS & GYP. BOARD. SEE DETAIL 6/A100.
5. REPURPOSE LOCKERS FOR REFRIGERANT LINES, REFER TO MECHANICAL DRAWINGS. PROVIDE PADLOCK FOR CUSTODIAL STAFF.
6. CONSTRUCT NEW CMU WALL, SEE DETAIL 8/A100.
7. REPLACE BRAKE METAL IN KIND WHERE REFRIGERANT LINES WERE REMOVED.



NORTH

KEY PLAN
SCALE: NONE

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES
3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

Drawing Title:
BUILDING "B"
FLOOR PLANS & DETAILS
State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: MCM
Project Number: 22.335

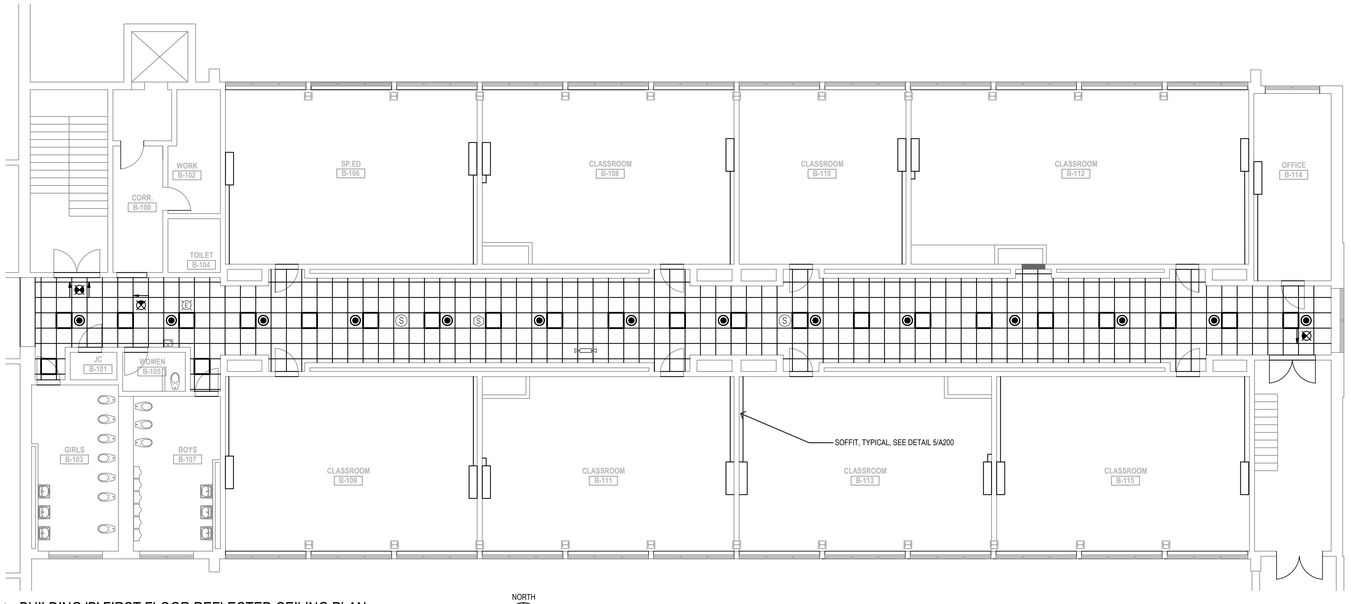
Drawing Number: A100

GENERAL NOTES

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R.C.P. SYMBOL LEGEND

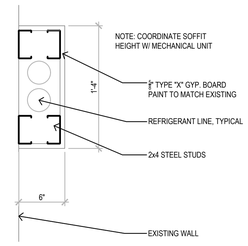
- 2' X 2' SUSPENDED ACOUSTICAL CEILING SYSTEM HANG AT 8'-6"
- LIGHTING FIXTURES, SEE ELECTRICAL LIGHTING DRAWINGS.
- EXIT LIGHTING, SEE ELECTRICAL LIGHTING DRAWINGS.
- MECHANICAL FIXTURES, SEE MECHANICAL DRAWINGS.
- SPRINKLER HEAD, SEE FIRE PROTECTION DRAWINGS



1 BUILDING 'B' FIRST FLOOR REFLECTED CEILING PLAN

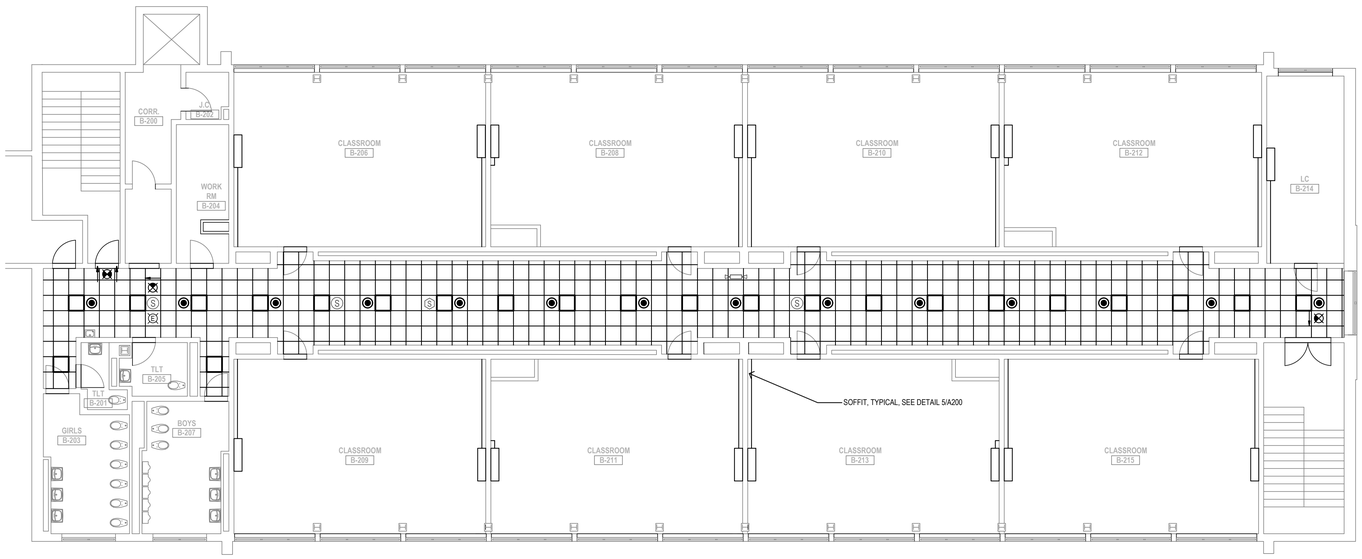
SCALE: 1/8" = 1'-0"

NORTH



5 REFRIGERANT LINE SOFFIT DETAIL

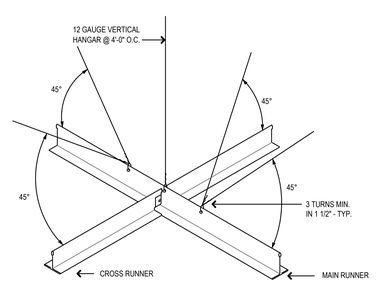
SCALE: 1.1/2" = 1'-0"

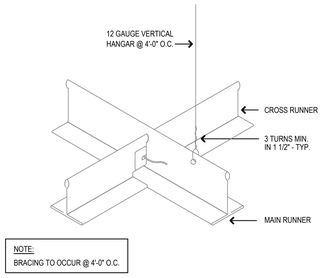


2 BUILDING 'B' SECOND FLOOR REFLECTED CEILING PLAN

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

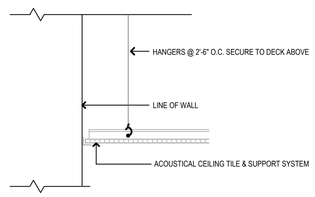
NORTH





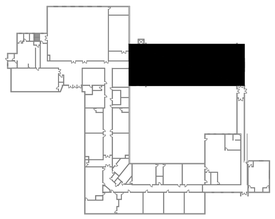
4 SEISMIC BRACING DETAIL

SCALE: 1.1/2" = 1'-0"



3 CEILING DETAIL

SCALE: 1.1/2" = 1'-0"



KEY PLAN

SCALE: NONE

NORTH

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES

3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

Drawing Title:

BUILDING "B"
REFLECTED CEILING PLANS

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: MCM
Project Number: 22.335

Drawing Number: A200

FIRE PROTECTION GENERAL NOTES

GENERAL

UTILIZE CONCEALED PENDENT SPRINKLERS AND PIPING IN AREAS WITH FINISHED CEILINGS, AND EXPOSED PIPING AND UPRIGHT SPRINKLERS IN AREAS WITHOUT CEILINGS. CONCEALED SPRINKLER HEADS LOCATED IN ACOUSTICAL TILES TO UTILIZE FLEX HOSE PIPING 6' IN LENGTH. PROVIDE AND INSTALL SPRINKLERS UNDER AND ABOVE ALL OBSTRUCTIONS IN ACCORDANCE WITH NFPA 13.

FIRE PROTECTION PLANS ARE INTENDED TO INDICATE TOTAL COVERAGE AND MAY OR MAY NOT INDICATE ALL SPRINKLER HEADS. SPRINKLER HEADS INDICATED ON DRAWINGS ARE DIAGRAMMATIC AND SHALL NOT BE NOT BE COUNTED FOR BID (IT IS NOT THE INTENT OF THESE DRAWINGS TO SHOW ENTIRE PIPING LAYOUT, PROPOSED MAINS AND DEVICES INDICATED ONLY) THE CONTRACTOR SHALL PROVIDE A COMPLETE SPRINKLER SYSTEM WITH COMPLETE SPRINKLER COVERAGE, INDICATED OR NOT. ITEMS AND SERVICES NOT SHOWN ON DRAWINGS OR SPECIFICATIONS BUT REQUIRED TO RENDER THE WORK COMPLETE, IN ACCORDANCE WITH NFPA, INSURANCE COMPANY REQUIREMENTS AND OWNERS, READY FOR OPERATION, SHALL BE PROVIDED AND INSTALLED. THE CONTRACTOR SHALL PROVIDE COMPLETE SPRINKLER COVERAGE AS REQUIRED INCLUDING BUT NOT LIMITED TO: CRAWL SPACES, CONCEALED COMBUSTIBLE SPACES, SHAFTS, AND ALL CLOSETS.

DRAWINGS ARE DIAGRAMMATIC AND INDICATE A GENERAL ARRANGEMENT OF WORK AND ARE NOT TO BE CONSIDERED SUBCONTRACTOR DOCUMENTS. IT IS THE INTENT OF THESE DOCUMENTS TO INCLUDE THE PROVISION AND INSTALLATION OF ALL NECESSARY WORK AND MATERIALS FOR COMPLETE, OPERATIONAL AND CODE COMPLIANT SYSTEMS BY THE CONTRACTOR. GENERAL DESIGN CONCEPTS INDICATED MUST BE FOLLOWED OR BETTERED. THE BID SHALL INCLUDE OFFSETS, ADDITIONAL PIPING, VALVES AND EQUIPMENT AND COMPONENTS AS REQUIRED TO MEET CONSTRUCTION CONDITIONS FOR PROPER OPERATION. DO NOT SCALE DRAWINGS. CONSULT ARCHITECTURAL AND STRUCTURAL DRAWINGS FOR SPACE CONDITIONS AND ADDITIONAL REQUIREMENTS.

WHEN A CONFLICT BETWEEN THE DRAWINGS, NOTES AND/OR SPECIFICATIONS OCCUR, THE MORE STRINGENT, AND/OR LARGER QUANTITY AND/OR MORE EXPENSIVE SHALL APPLY. THE REQUIREMENTS LISTED WITHIN NOTES OR SPECIFICATIONS SHALL BE REQUIRED, PROVIDED AND INSTALLED WHETHER SPECIFICALLY INDICATED ON THE DRAWINGS OR NOT.

THE CONTRACTOR SHALL COORDINATE SPRINKLER HEAD LOCATIONS WITH THE LATEST ARCHITECTURAL REFLECTED CEILING PLANS. ANY DISCREPANCIES SHALL BE BROUGHT BACK TO THE ARCHITECT/ ENGINEER. DO NOT SCALE DRAWINGS FOR DIMENSIONS NOT INDICATED. REFER TO ARCHITECT FOR RESOLUTION FOR ANY DIMENSIONS NOT INDICATED.

IT IS THE INTENTION OF THE SPECIFICATIONS AND DRAWINGS TO PROVIDE FOR FINISHED WORK, TESTED AND READY FOR OPERATION.

THE DESIGN OF ALL FIRE SUPPRESSION SYSTEMS WILL BE IN ACCORDANCE WITH THE LOCAL AND STATE BUILDING CODE, NFPA 13, FM GLOBAL USE ONLY UL/FM SPRINKLERS, MATERIALS AND DEVICES, UNLESS NOTED OTHERWISE.

CONCEALED SPRINKLERS AND PIPING SHALL BE INSTALLED IN AREAS WITH FINISHED CEILINGS. AREAS WITH EXPOSED CONSTRUCTION SHALL HAVE EXPOSED PIPING AND SPRINKLERS (CUSTOM COLOR)

THE SPRINKLER CONTRACTOR IS REQUIRED TO VISIT THE SITE AT THE TIME OF BID, TO EXAMINE CONDITIONS AND BECOME FAMILIAR WITH THE JOB, NOTING DEGREE OF DIFFICULTY IN GETTING EQUIPMENT (INCLUDING LIFTS AND SCAFFOLDS) IN AND OUT OF THE BUILDING. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE ARCHITECT OR ENGINEER IN WRITING PRIOR TO SUBMITTING A BID.

NOTIFY PROPER AUTHORITIES (INCLUDING BUT NOT LIMITED TO: THE LOCAL A.H.J., INSURANCE COMPANY, ETC.) OF ANY FIRE PROTECTION "SHUT DOWNS". SCHEDULE ALL WORK TO MINIMIZE THE LENGTH OF TIME THAT THE FIRE PROTECTION SYSTEM(S) WILL BE OUT OF SERVICE. RETURN THE SPRINKLER SYSTEM BACK IN SERVICE AT THE END OF EACH WORKING DAY. IF A FIRE WATCH IS REQUIRED BY THE LOCAL A.H.J. BUILDING MANAGER, ETC. IT SHALL BE PROVIDED BY THE GENERAL CONTRACTOR. FIRE WATCH SCHEDULING AND PERSONNEL SHALL BE COORDINATED WITH THE LOCAL A.H.J., BUILDING MANAGER AND INSURANCE COMPANY.

ARRANGE PIPING TO FACILITATE FLUSHING. PROVIDE READILY ACCESSIBLE DRAIN AND FLUSHING CONNECTIONS AS REQUIRED BY NFPA 13. PROVIDE AND INSTALL AUXILIARY DRAINS WITH PROVISIONS FOR COMPLETE DRAINAGE. PIPE ALL DRAINS TO AN APPROVED LOCATION.

INSPECTOR'S TEST CONNECTIONS, DRAIN VALVES AND CONTROL VALVES SHALL BE READILY ACCESSIBLE AND INSTALLED NOT OVER +/-7'-0" ABOVE THE FINISHED FLOOR. PROVIDE ALL VALVES WITH IDENTIFICATION SIGNS. SUPERVISORY SWITCHES SHALL BE ON ALL CONTROL VALVES. PIPE ALL DRAIN PIPING, INSPECTORS TEST CONNECTIONS, ETC. TO THE EXTERIOR. ENSURE DRAINAGE DOES NOT CAUSE DAMAGE TO BUILDING OR SITE.

INSTALL A PRESSURE GAUGE WITH A BLEEDER MAINTENANCE VALVE AT THE TOP OF ALL RISERS.

PROVIDE A HEAD GUARD ON SPRINKLERS IN AREAS SUBJECT TO MECHANICAL DAMAGE (I.E. SPRINKLERS IN: MECHANICAL ROOMS, ETC.)

REFER TO ADDITIONAL NOTES ON ARCHITECTURAL DRAWINGS.

THE CONTRACTOR SHALL COORDINATE SPRINKLER WORK WITH THE OWNER'S PHASING SCHEDULE PRIOR TO COMMENCEMENT OF ANY WORK. ALL PHASED SECTIONS OF WORK SHALL COMPLY WITH THE OWNERS SCHEDULE AND BE TESTED, INSPECTED, READY FOR OPERATION IN ACCORDANCE WITH NFPA, OWNERS INSURANCE COMPANY AND A.H.J. REQUIREMENTS.

THE CONTRACTOR SHALL PROVIDE COMPLETE SIGNED AND SEALED (BY LICENSED P.E.) DRAWINGS INDICATING ALL PIPING AND SPRINKLER HEADS. CONTRACTOR SHALL SECURE AND PAY COSTS OF PERMITS, CERTIFICATES, LICENSES, INSPECTIONS AND APPROVALS.

INSTALL SPRINKLERS BELOW DUCTS, AND/OR COMBINATIONS OF DUCTS/EQUIPMENT IN ACCORDANCE WITH THE OBSTRUCTION REQUIREMENTS OF NFPA 13.

PROVIDE SPRINKLER PROTECTION IN ORDER TO AVOID ALL OBSTRUCTIONS IN ACCORDANCE WITH NFPA 13, INCLUDING: LIGHTING, CEILING FIXTURES, STRUCTURAL MEMBERS, ETC. WITHIN ALL HAZARD OCCUPANCIES.

ALL DRAIN PIPING AND ANY PIPING SUBJECT TO ALTERNATE WETTING AND DRYING SHALL BE GALVANIZED.

ALL SYSTEM COMPONENTS SHALL BE CAPABLE OF WITHSTANDING A MINIMUM WORKING PRESSURE OF 175 PSI.

THE CONTRACTOR SHALL SEAL AROUND ALL NEW PENETRATIONS THROUGHOUT THE BUILDING WITH SEALANT OF FIRE AND/OR SMOKE RETARDANT TYPE EQUAL IN FIRE RATING TO THE STRUCTURE BEING PENETRATED. SEALANT SHALL BE A UL LISTED ASSEMBLY.

WORK OF THIS SECTION SHALL BE GOVERNED BY THE CONTRACT DOCUMENTS. PROVIDE MATERIALS, LABOR, EQUIPMENT AND SERVICES NECESSARY TO FURNISH, DELIVER AND INSTALL ALL WORK AS SPECIFIED AND AS REQUIRED BY JOB CONDITIONS. WHERE A CONFLICT EXISTS BETWEEN THESE NOTES, THE DRAWINGS AND THE SPECIFICATIONS, THE MORE STRINGENT REQUIREMENT SHALL APPLY.

PERFORM THE WORK IN ACCORDANCE WITH THE REQUIREMENTS OF THE CONTRACT GENERAL CONDITIONS AND WITH THE PROVISIONS OF ALL APPLICABLE LOCAL, STATE, AND FEDERAL CODES AND LAWS.

WORK SHALL INCLUDE ALL INCIDENTALS, LABOR, MATERIAL, EQUIPMENT, APPLIANCES, SERVICES, HOISTING, SCAFFOLDING, SUPPORTS, TOOLS, CONSUMABLE ITEMS, FEES, LICENSES, AND ADMINISTRATIVE TASKS REQUIRED TO COMPLETE AND MAKE OPERABLE WORK SHOWN ON THE DRAWINGS, SPECIFIED HEREIN AND AS REQUIRED FOR A COMPLETE AND OPERATIONAL SYSTEM..

STORE MATERIALS INSIDE AND PROTECTED FROM DEBRIS, WEATHER AND MOISTURE.

THIS CONTRACTOR SHALL PROVIDE AND INSTALL ALL POWER AND CONTROL WIRING REQUIRED FOR EQUIPMENT OPERATION NOT SPECIFICALLY PROVIDED BY OTHERS BUT REQUIRED FOR A COMPLETE AND OPERATIONAL SYSTEM. THIS CONTRACTOR SHALL PROVIDE MOTOR STARTERS FOR INSTALLATION BY OTHERS. COORDINATE REQUIREMENTS.

ALTERATION WORK AND DEMOLITION

EXISTING PIPING AND SPRINKLERS SHOWN DO NOT NECESSARILY REFLECT EXACT FIELD CONDITIONS. FIELD VERIFY EXTENT AND LOCATION OF WORK TO BE REMOVED.

ALL EQUIPMENT, PIPING, ETC. TO BE REMOVED, SHALL BE DISPOSED OF. TURNED OVER TO THE OWNER, OR SALVAGED AS DIRECTED BY THE OWNER. EQUIPMENT, PIPING, DEVICES, ETC. SHALL NOT BE REMOVED FROM THE PREMISES WITHOUT THE OWNER'S APPROVAL.

NO EXISTING PIPE MAY BE CUT OR DAMAGED WHEN ENCOUNTERED ALONG THE ROUTE DESIGNED FOR NEW SERVICE. ANY EXISTING PIPING SEVERED OR DAMAGED SHALL BE REPLACED INCLUDING DAMAGED AREAS. ANY UNUSED OUTLETS SHALL BE PROPERLY CAPPED.

UPON COMPLETION OF REMOVALS AND MODIFICATIONS, ALL PIPING TO REMAIN SHALL BE PROPERLY PLUGGED, VALVED, CAPPED AND/OR BY PASSED SUCH THAT UPON COMPLETION OF WORK ALL SYSTEMS TO REMAIN, REMAIN OPERATIONAL.

REMOVE & REPLACE ANY EXISTING SPRINKLER PIPING WHICH DOES NOT PASS THE REQUIRED HYDROSTATIC PRESSURE TESTS CONDUCT VISUAL INTERNAL INSPECTIONS ON AT LEAST 5% OF ANY EXISTING PIPING TO REMAIN.
NO DEAD ENDS SHALL BE LEFT ON ANY PIPING SYSTEMS UPON COMPLETION OF WORK.

EXISTING EXPOSED PIPING SYSTEMS NOT TO BE REUSED, AND NOT SPECIFICALLY NOTED FOR REMOVAL SHALL BE COMPLETELY REMOVED.

ALL SYSTEMS SHALL BE LEFT IN WORKING ORDER TO THE SATISFACTION OF THE OWNER UPON COMPLETION OF ALL NEW WORK.

ALL EXISTING EXPOSED, UNNECESSARY PIPING RELATED TO NEW WORK SHALL BE COMPLETELY REMOVED.

RE-ROUTE OR REMOVE ALL EXISTING PIPING AND SYSTEMS WHERE NECESSARY TO AVOID NEW EQUIPMENT, STRUCTURAL, OR MASONRY WORK AS REQUIRED BY THE PROPOSED ALTERATIONS.

COORDINATION DRAWINGS

DEVELOP AND SUBMIT COORDINATION DRAWINGS AS OUTLINED.

SHEET METAL, PLUMBING AND FIRE PROTECTION SHOP DRAWINGS THAT HAVE BEEN COORDINATED WITH ARCHITECTURAL AND STRUCTURAL DRAWINGS SHALL BE SUBMITTED TO ENGINEER FOR REVIEW. DRAWINGS MUST BE RETURNED FROM ENGINEER EITHER "REVIEWED" OR "FURNISH AS CORRECTED" PRIOR TO BEING USED AS BASIS FOR COORDINATION DRAWINGS.

AFTER SHEET METAL AND PIPING DRAWINGS HAVE BEEN REVISED PER ENGINEERS COMMENTS, REPRODUCIBLE COPIES SHALL BE SENT TO THE TRADES IN THE FOLLOWING SEQUENCE FOR THE INCLUSION OF THEIR WORK:

-MECHANICAL SHEET METAL
-PLUMBING PIPING
-MECHANICAL PIPING
-SPRINKLER PIPING
-ELECTRICAL WORK

AFTER ALL TRADES HAVE INCLUDED THEIR WORK ON THE COORDINATION DRAWING AND NOTED CONFLICTS, ALL TRADES SHALL MEET TO RESOLVE CONFLICTS AND AGREE TO ACCEPTABLE SOLUTIONS. EACH TRADE SHALL SIGN COORDINATION DRAWINGS. ITEMS NOT SHOWN ON COORDINATION DRAWING IS RESPONSIBILITY OF OMITTING CONTRACTOR AND CONTRACTOR IS SUBJECT TO ADDITIONAL COSTS INCURRED BY OTHER TRADES.

THE ARCHITECT AND ENGINEER ARE NOT PART OF THE COORDINATION DRAWING PROCESS. THE ENGINEER WILL PROVIDE ASSISTANCE FOR NOTED CONFLICTS ONLY. COORDINATION DRAWINGS ARE NOT TO BE CONSIDERED PIPING OR DUCT SHOP DRAWINGS. THE CONTRACTOR IS REQUIRED TO SUBMIT INDIVIDUAL PIPING AND DUCTWORK SHOP DRAWINGS FOR REVIEW BY THE ENGINEER. PIPING AND DUCTWORK SHOP DRAWINGS SHALL FOLLOW THE DESIGN INTENT OF THE CONTRACT DOCUMENTS.

SUBMIT FINAL SIGNED COORDINATION DRAWING TO ENGINEER FOR REVIEW. ENGINEER WILL REVIEW COORDINATION DRAWINGS FOR GENERAL ARRANGEMENT AND FOR NOTED CONFLICTS ONLY. SPECIFIC INSTALLATION REQUIREMENTS WILL BE REVIEWED ONLY IN INDIVIDUAL TRADE SHOP DRAWINGS.

WHERE CONFLICTS OCCUR BETWEEN DRAWINGS AND SPECIFICATIONS, OR WITHIN EITHER DOCUMENT, THE CONTRACTOR SHALL ASK FOR AND OBTAIN A WRITTEN CLARIFICATION FROM THE ENGINEER PRIOR TO SUBMITTING HIS BID. OTHERWISE, THE ITEMS OR ARRANGEMENTS OF SUPERIOR QUALITY, GREATER QUANTITY OR HIGHER COST SHALL PREVAIL AND BE INCLUDED IN THE CONTRACT PRICE.

ANY WORK FABRICATED OR INSTALLED PRIOR TO SIGN OFF BY ALL TRADES WHICH IS DEEMED TO BE IN CONFLICT WITH COORDINATION DRAWINGS SHALL BE REMOVED AND RE-INSTALLED IN CONFORMANCE WITH COORDINATION DRAWINGS.

EACH CONTRACTOR (MENTIONED ABOVE) IS RESPONSIBLE FOR THE COORDINATION OF HIS SUB-CONTRACTORS.

THE OVERALL COORDINATION OF THE COORDINATION PROCESS IS THE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER IS NOT RESPONSIBLE FOR THE COORDINATION PROCESS. THE ENGINEER WILL RESPOND TO QUESTIONS THAT ARISE FROM THE COORDINATION PROCESS. DRAWINGS SUBMITTED WILL BE REVIEWED FOR CLEARLY IDENTIFIED CONFLICTS ONLY. SOLUTIONS TO CONFLICTS WILL NOT BEAR ADDITIONAL COST.

AS BUILT DRAWINGS

PROVIDE A COMPLETE SET OF AS-BUILT DRAWINGS REFLECTING AS INSTALLED CONDITIONS. AS-BUILT DRAWINGS SHALL INDICATE ALL INSTALLED CONDITIONS OF SYSTEMS WITHIN THIS DISCIPLINE. DRAWINGS SHALL BE OF SIMILAR SCALE AS THE CONSTRUCTION DOCUMENTS AND INCLUDE DETAILS AS NECESSARY TO CLEARLY REFLECT THE INSTALLED CONDITION. DRAWINGS SHALL BE BOUND IN A COMPLETE AND CONSECUTIVE SET. SUPPLEMENTAL SKETCHES AND LOOSE PAPERWORK WILL NOT BE ACCEPTABLE AND WILL BE RETURNED FOR REVISION. THE CONTRACTOR SHALL COMPLY WITH THE ENGINEERS COMMENTS TO PRODUCE A CLEAR AND CONCISE SET OF DRAWINGS. DRAWINGS SHALL BE SUBMITTED IN BOTH HARD COPY AND ELECTRONIC (AUTO-CAD AND/ VERSION AS REQUIRED BY THE OWNER) VERSION. NUMBER OF COPIES OF EACH AS REQUESTED BY THE OWNER.

INCLUDE ALL CHANGES OF ALL DEVIATIONS BETWEEN THE WORK INDICATED AND THE WORK INSTALLED INCLUDING APPROVED CONTRACT MODIFICATIONS AND SUBSTITUTIONS.

SUBMIT A COMPLETE MAINTENANCE MANUAL OF ALL EQUIPMENT INSTALLED UNDER THIS CONTRACT.

HANGERS AND SUPPORT
SPRINKLER PIPING IN A SUBSTANTIAL MANNER FROM BUILDING STRUCTURE, AND INDEPENDENT OF THE CEILING SYSTEM. PROVIDE EARTHQUAKE/SEISMIC BRACING IN ACCORDANCE WITH NFPA 13 AND THE LOCAL CODE. DO NOT USE SPRINKLER PIPING OR HANGERS TO SUPPORT NON-SYSTEM COMPONENTS.

SEISMIC RESTRAINT: PROVIDE SEISMIC RESTRAINT AND EXPANSION OF ALL FIRE PROTECTION EQUIPMENT AND SYSTEMS IN ACCORDANCE WITH APPLICABLE NFPA STANDARDS, OWNERS INSURANCE COMPANY, STATE, FEDERAL AND LOCAL BUILDING CODE REQUIREMENTS. SUBMIT SHOP DRAWINGS SIGNED AND SEALED BY A LICENSED PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF THE PROJECT INDICATING ALL NECESSARY COMPONENT CUTS, PLAN LOCATIONS AND CALCULATIONS FOR A COMPLETE SYSTEM.

PROVIDE ALL NECESSARY STRUCTURAL MEMBERS INCLUDING ADDITIONAL STRUCTURAL SUPPORT TO SUPPORT PIPING AND EQUIPMENT. HANGERS AND SUPPORTS SHALL BE OF AN APPROVED DESIGN NECESSARY TO SUPPORT PIPING, EQUIPMENT AND TO KEEP PIPING IN PROPER ALIGNMENT AND PREVENT TRANSMISSION OF INJURIOUS THRUSTS AND VIBRATIONS. IN ALL CASES WHERE HANGERS, BRACKETS, ETC., ARE SUPPORTED FROM CONCRETE CONSTRUCTION, DO NOT WEAKEN CONCRETE OR PENETRATE WATERPROOFING. ALL HANGERS AND SUPPORTS SHALL BE CAPABLE OF SCREW ADJUSTMENT AFTER PIPING IS ERECTED. HANGERS SUPPORTING PIPING EXPANDING INTO LOOPS, BENDS AND OFFSETS SHALL BE SECURED TO THE BUILDING STRUCTURE IN SUCH A MANNER THAT HORIZONTAL ADJUSTMENT PERPENDICULAR TO THE RUN OF PIPING SUPPORTED MAY BE MADE TO ACCOMMODATE DISPLACEMENT DUE TO EXPANSION. ALL SUCH HANGERS SHALL BE FINALLY ADJUSTED BOTH IN THE VERTICAL AND HORIZONTAL DIRECTION, AS REQUIRED.

PROVIDE ADDITIONAL SUPPORT FOR PIPING AND EQUIPMENT WHEN DECK IS NOT CAPABLE OF SUPPORT.

BEAM CLAMPS - HANGERS SUPPORTED FROM STEEL SHALL BE CENTER LOADING BEAM CLAMPS FOR HANGERS SUPPORTING PIPING 2 INCHES. FOR PIPING 2-1/2 INCHES AND LARGER, I BEAM CLAMPS SHALL BE FORGED STEEL. "C" CLAMPS ARE PERMITTED ONLY WHEN PROVIDED WITH RESTRAINING STRAP. BAR JOIST HANGERS SHOULD BE UTILIZED WHEN HANGING FROM BAR JOIST CONSTRUCTION.

ALL HANGERS AND SUPPORTS SHALL BE HOT DIPPED GALVANIZED. ALL THREADED ROD AND HARDWARE SHALL BE HOT DIPPED GALVANIZED.

PROVIDE AND INSTALL EXPANSION COMPENSATION FOR ALL PIPING. SUBMIT PLANS, CALCULATIONS AND EQUIPMENT DATA.

FIRE PROTECTION DESIGN CRITERIA

WORK STARTS AT AREAS INDICATED, INCLUDING BUT NOT LIMITED TO REMOVAL OF: EXISTING SPRINKLER PIPING, HEADS, HANGERS, ETC. AND INSTALLATION OF NEW SPRINKLER HEADS, SPRINKLER PIPING, OFFSETS, ETC. AS NECESSARY TO PROVIDE COMPLETE SPRINKLER PROTECTION IN THE RENOVATED AREAS.

THE DESIGN OF ALL FIRE SUPPRESSION SYSTEMS WILL BE IN ACCORDANCE WITH THE 2021 STATE OF CONNECTICUT BUILDING & FIRE CODE, LOCAL CODE AND THE OWNER'S INSURANCE COMPANY REQUIREMENTS. USE ONLY UL/FM APPROVED SPRINKLERS, MATERIALS AND DEVICES, UNLESS NOTED OTHERWISE.

WORK SHALL ALSO INCLUDE PROVIDING PIPING, FITTINGS, ETC. AS NECESSARY TO SUPPLY EXISTING, ADJACENT SPRINKLERS OUTSIDE OF RENOVATED AREA

CONTRACTOR RESPONSIBLE FOR DOCUMENTING SIZE AND LENGTH OF EXISTING WATER SUPPLY INCLUDING SIZE OF ANY EXISTING FIRE PUMP, ETC. AS NECESSARY IN ORDER TO SUBMIT A COMPLETE DESIGN.

THE CONTRACTOR SHALL PROVIDE SPRINKLER COVERAGE OF ALL SPACES FORMED OF CONCEALED COMBUSTIBLE CONSTRUCTION.

THE CONTRACTOR SHALL COMPLY WITH THE OWNERS INSURANCE INSTALLATION DETAILS, DESIGN CRITERIA, AND PLAN APPROVAL SUBMISSION (INCLUDING COMMENTS). ANY DEVIATIONS AS A RESULT OF THE OWNERS INSURANCE COMPANIES REQUIREMENTS SHALL BE PROVIDED AT NO ADDITIONAL COST.

USE OF LINE SPACING OFF WALL IN EXCESS OF 7"-6", ETC, (AS NOTED IN NFPA 13) IS NOT PERMITTED.

CONTRACTOR TO SUBMIT UNIT COST PER SPRINKLER HEAD INSTALLED AND OPERATIONAL WITH BID IN ACCORDANCE WITH THE GENERAL CONDITIONS (INCLUDING: PIPING, FITTINGS, HANGERS, SPRINKLER HEAD, LABOR, ETC.).

PIPE SCHEDULE DESIGN CRITERIA

AS REQUIRED, CONTRACTOR SHALL SUBMIT PLANS TO OWNER'S INSURANCE COMPANY INCLUDING: PLANS, EQUIPMENT, ETC. FOR REVIEW/COMMENTS. COMPLY WITH ALL INSURANCE COMPANY REQUIREMENTS

CONTRACTOR TO SUBMIT UNIT COST PER SPRINKLER HEAD (INCLUDING: PIPING, FITTINGS, HANGERS, SPRINKLER HEAD, LABOR, ETC.) INSTALLED AND OPERATIONAL WITH BID IN ACCORDANCE WITH THE GENERAL CONDITIONS.

DESIGN CRITERIA FOR PIPE SCHEDULE SYSTEMS:

LIGHT HAZARD AREAS:
OFFICES, HALLWAYS, LOBBYS, ETC. MAXIMUM COVERAGE PER SPRINKLER HEAD IS 196 SQ.FT.

ORDINARY HAZARD (GROUP I) AREAS:
MECHANICAL ROOMS, ELECTRICAL ROOMS, ETC. MAXIMUM COVERAGE PER SPRINKLER HEAD IS 130 SQ.FT.

ORDINARY HAZARD (GROUP II) AREAS:
STORAGE ROOMS MAXIMUM COVERAGE PER SPRINKLER HEAD IS 130 SQ.FT.

ALL FIRE PROTECTION EQUIPMENT SHALL BE FM APPROVED AND UL LISTED.

FIRE PROTECTION DEMOLITION NOTES

1. ALL DRAWINGS, SPECIFICATIONS, EQUIPMENT, ETC. SHALL BE SUBMITTED AND REVIEWED BY THE FIRE MARSHAL PRIOR TO INSTALLATION. CONTRACTOR SHALL INCORPORATE ALL COMMENTS INTO PROJECT AT NO ADDITIONAL COST.
2. NOTIFY PROPER AUTHORITIES (INCLUDING BUT NOT LIMITED TO: THE LOCAL A.H.J., INSURANCE COMPANY, ETC.) OF ANY FIRE PROTECTION "SHUT DOWNS". SCHEDULE ALL WORK TO MINIMIZE THE LENGTH OF TIME THAT THE FIRE PROTECTION SYSTEM(S) WILL BE OUT OF SERVICE. RETURN THE SPRINKLER SYSTEM BACK IN SERVICE AT THE END OF EACH WORKING DAY.
3. THIS JOB IS A RENOVATION OF EXISTING FACILITY.
4. THE CONTRACTOR SHALL VISIT THE SITE AND BECOME THOROUGHLY FAMILIAR WITH ALL EXISTING CONDITIONS. THE CONTRACTOR SHALL BE HELD RESPONSIBLE FOR ANY ASSUMPTIONS, OMISSIONS, OR ERRORS HE MAKES AS A RESULT OF HIS FAILURE TO BECOME FULLY FAMILIAR WITH EXISTING CONDITIONS.
5. THE SPRINKLER CONTRACTOR SHALL REMOVE AND PROPERLY DISPOSE OF ALL EXISTING SPRINKLER PIPING, HANGERS, HEADS, ETC. AS INDICATED (VERIFY IN FIELD) CAP ANY UNUSED OUTLETS.
6. THE CONTRACTOR SHALL PROPERLY CAP AND TERMINATE ANY UNUSED DRAIN AND FIRE PROTECTION WATER SUPPLIES (IN ACCORDANCE WITH THE LOCAL WATER AUTHORITY REQUIREMENTS).

FIRE PROTECTION SYMBOL LEGEND

SYMBOL	DESCRIPTION
	BALL VALVE
	CHECK VALVE
	GATE VALVE
	REDUCED PRESSURE BACKFLOW PREVENTER
	HYDRANT
	PRESSURE GAUGE
	ALARM BELL
	FIRE DEPARTMENT CONNECTION (FDC)
	REDUCED PRESSURE DETECTOR ASSEMBLY
	OSY VALVE
	POINT OF NEW CONNECTION
	POINT OF DISCONNECTION
AF	ANTIFREEZE CHARGING LOOP
SEJ	SEISMIC EXPANSION JOINT
	TEST AND DRAIN VALVE
FS	FLOW SWITCH
PS	PRESSURE SWITCH
TS	TAMPER SWITCH
	PIPE DOWN
	PIPE UP
	CAPPED PIPE
	PIPE OR EQUIPMENT TO BE DEMOLISHED

SPRINKLER SYMBOL LEGEND

EXISTING	NEW	DESCRIPTION
		UPRIGHT
		PENDENT
		PENDENT - SEMI RECESSED
		PENDENT - RECESSED
		PENDENT - CONCEALED
		DRY PENDENT
		DRY PENDENT - SEMI RECESSED
		DRY PENDENT - RECESSED
		DRY PENDENT - CONCEALED
		SIDEWALL
		SIDEWALL - RECESSED
		DRY SIDEWALL
		DRY SIDEWALL - RECESSED
		EXPOSED UPRIGHT OFF 1" SPRIG-UP FED FROM HEAD BELOW

NOTE: SOME SYMBOLS AND ABBREVIATIONS SHOWN MAN NOT PERTAIN TO THIS PROJECT.

FIRE PROTECTION PIPING SYSTEM LEGEND

EXISTING	NEW	DESCRIPTION
SP	SP	UNDERGROUND PIPING MAIN
FDC	FDC	UNDERGROUND FIRE DEPARTMENT CONNECTION
T/D	T/D	TEST / DRAIN
T	T	TEST
STP	STP	STAND PIPE
		SPRINKLER
PA	PA	PRE ACTION
SP	SP	WET SPRINKLER
FDC	FDC	FIRE DEPARTMENT CONNECTION
		EQUIPMENT
DRY	DRY	DRY PIPE
DR	DR	DRAIN
AF	AF	ANTIFREEZE

FIRE PROTECTION ABBREVIATIONS

ABBREVIATION	DESCRIPTION
ACV	ALARM CHECK VALVE
A.F.F.	ABOVE FINISHED FLOOR
A.F.G.	ABOVE FINISHED GRADE
B.F.F.	BELOW FINISHED FLOOR
BFP	BACKFLOW PREVENTER
BIV	BUTTERFLY INDICATING VALVE
BLDG	BUILDING
C.E.	CIVIL ENGINEER
CONT	CONTINUED
CV	CHECK VALVE
DIA.	DIAMETER
DIP	DUCTILE IRON PIPE
DN	DOWN
DWG	DRAWING
EA.	EACH
E.C.	ELECTRICAL CONTRACTOR
EX.	EXISTING
FCV	FLOOR CONTROL VALVE
FDV	FIRE DEPARTMENT VALVE
F.F.	FINISHED FLOOR
F.F.E.	FINISHED FLOOR ELEVATION
FLR.	FLOOR
F.P.C.	FIRE PROTECTION CONTRACTOR
FT.	FEET
G.C.	GENERAL CONTRACTOR
GPM	GALLONS PER MINUTE
MAX.	MAXIMUM
M.C.	MECHANICAL CONTRACTOR
MIN.	MINIMUM
MISC.	MISCELLANEOUS
NC	NORMALLY CLOSED
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
N.I.C.	NOT IN CONTRACT
NO	NORMALLY OPEN
NTS	NOT TO SCALE
OSY	OUTSIDE SCREW AND YOKE
P.C.	PLUMBING CONTRACTOR
PIV	POST INDICATING VALVE
PSI	POUNDS PER SQUARE INCH
RAD.	RADIUS
RPBFP	REDUCED PRESSURE BACKFLOW PREVENTER
S.C.	SITE CONTRACTOR
SF	SQUARE FEET
SS	SANITARY SEWER STACK
TB	THRUST BLOCK
TYP.	TYPICAL
U.O.N.	UNLESS OTHERWISE NOTED
V.I.F.	VERIFY IN FIELD
Ø	DIAMETER

NOTE: SOME SYMBOLS AND ABBREVIATIONS SHOWN MAY NOT PERTAIN TO THIS PROJECT

FIRE PROTECTION DRAWING INDEX

SHEET	DESCRIPTION
FP001	GENERAL NOTES
FP110	BUILDING "B" FIRST AND SECOND PARTIAL FLOOR PLANS
FP201	SCHEDULES AND DETAILS

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES
3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

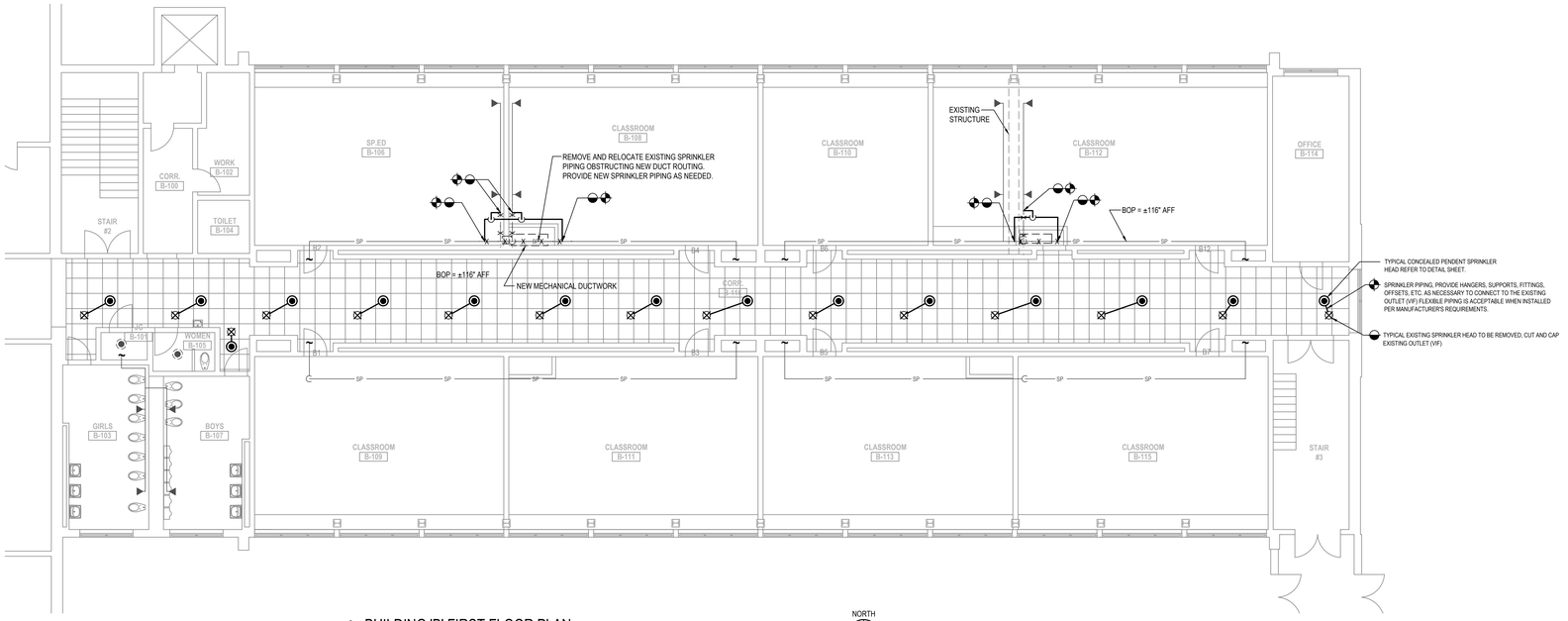
Revision: Description: Date: Revised By:

Drawing Title: GENERAL NOTES

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: MPB
Project Number: 22.335

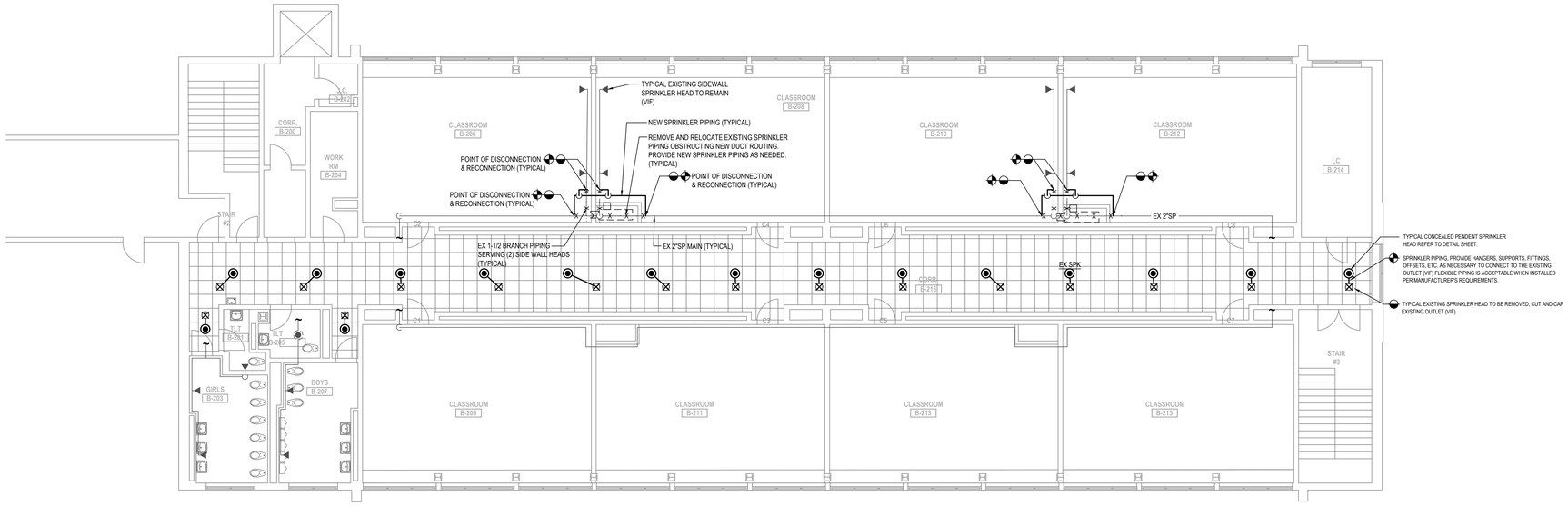
Drawing Number: FP001



1 BUILDING 'B' FIRST FLOOR PLAN

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

NORTH

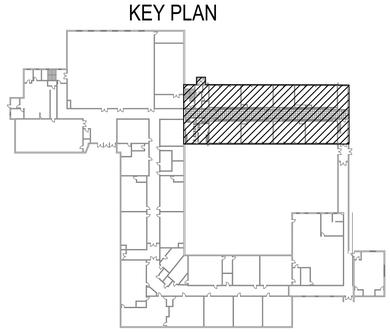


2 BUILDING 'B' SECOND FLOOR PLAN

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

NORTH

KEY PLAN



Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES

3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

Drawing Title:

BUILDING "B" FIRST AND SECOND
PARTIAL FLOOR PLANS

State Project #144-_ _ _ _ _ _

Date: 2-09-2024

Scale: AS NOTED

Drawn By: MPB

Project Number: 22.335

Drawing Number: FP110

SPRINKLER HEAD SCHEDULE

TYPE	STYLE	RESPONSE	COVERAGE	COLOR	DISCHARGE COEFFICIENT (K)	ORIFICE	TEMP.	MANUFACTURE		REMARKS
								MODEL	SIN	
PENDENT	CONCEALED	QUICK	STANDARD	WHITE	5.6K	1/2"	155°F	VICTAULIC		--
								V38	V3802	
PENDENT	EXPOSED	QUICK	STANDARD	BRASS	5.6K	1/2"	155°F	VICTAULIC		--
								V27	V2708	
SIDE WALL	EXPOSED	QUICK	STANDARD	BRASS	5.6K	1/2"	155°F	VICTAULIC		--
								V27	V2710	
UPRIGHT	EXPOSED	QUICK	STANDARD	BRASS	5.6K	1/2"	155°F	VICTAULIC		SEE NOTE 5
								V27	V2704	

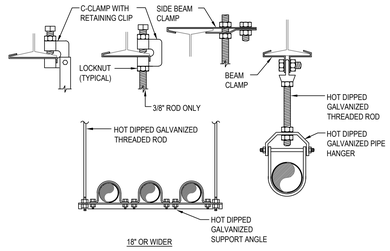
NOTES:
1. FINAL COLORS TO BE SELECTED BY ARCHITECT.
2. IN AREAS WITH FINISHED CEILINGS CONCEALED, PENDENT SPRINKLER HEADS AND CONCEALED PIPING SHALL BE UTILIZED, UNLESS OTHERWISE INDICATED ON PLANS.
3. IN AREAS WITHOUT CEILINGS, EXPOSED UPRIGHT SPRINKLER HEADS AND EXPOSED PIPING SHALL BE UTILIZED. UL LISTED HEAD GUARDS SHALL BE PROVIDED IN AREAS SUBJECT TO DAMAGE (I.E. MECHANICAL ROOMS, GYMS, ETC.)
4. FLEXIBLE SPRINKLER HEAD ASSEMBLIES SHALL BE 6' IN LENGTH, UL LISTED AND HAVE A STAINLESS STEEL BRAID SIMILAR TO VICTAULIC "VICFLEX" AQB BRAIDED SERIES. FLEXIBLE SPRINKLER ASSEMBLIES EQUIVALENT LENGTH MUST BE TAKING IN ACCOUNT WHEN PRODUCING HYDRAULIC CALCULATIONS.
5. PROVIDE HIGH-TEMPERATURE CLASSIFICATION SPRINKLERS IN HIGH-TEMPERATURE ZONES, AND PROVIDE INTERMEDIATE-TEMPERATURE CLASSIFICATION SPRINKLER IN INTERMEDIATE TEMPERATURE ZONES ADJACENT TO FINALIZED UNIT HEATER LOCATION (BY MECH DIV.). INSTALL IN ACCORDANCE WITH NFPA 13.

PIPE AND FITTING SCHEDULE

DESCRIPTION	SIZE	PIPE		FITTING		REMARKS
		TYPE	SCHEDULE	TYPE	RATING	
WET SPRINKLER PIPING	2" AND SMALLER	STL-BLK	40	MIT	STD	--
WET SPRINKLER PIPING	2-1/2" AND LARGER	STL-BLK	10	GRV	STD	--
DRAIN PIPING	ALL	GALV.	40	MIT/GRV	STD	ALL FITTINGS MUST BE GALVANIZED

NOTES:
1. ALL EXPOSED PIPING AND FITTINGS WITHIN FINISHED AREAS SHALL BE CUSTOM PAINTED IN ACCORDANCE WITH NFPA, OWNERS PAINTING REQUIREMENTS AND COORDINATED WITH ARCHITECT.
2. ALL PIPING IN RETURN AIR CEILING PLENUM INSTALLATIONS SHALL BE UL LISTED FOR THIS APPLICATION.

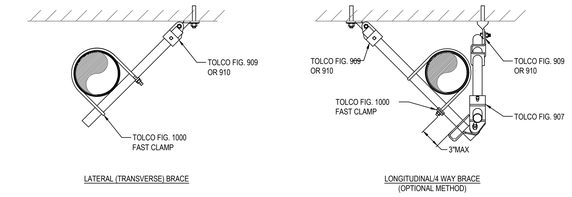
ABBREVIATIONS	DESCRIPTION	ABBREVIATIONS	DESCRIPTION
CI	CAST IRON	GRV	GROOVED JOINT SYSTEM FITTINGS/COUPLINGS
DI	DUCTILE IRON	GALV.	GALVANIZED STEEL
DIMJ	DUCTILE IRON MECHANICAL JOINT	MIT	MALLEABLE IRON THREADED
FL	FLANGED	STD	STANDARD
		STL-BLK	BLACK STEEL



18" OR WIDER

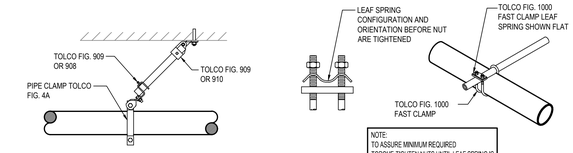
PIPE SIZE	MAX SPACING STEEL PIPE EXCEPT THREADED LIGHTWALL	MAX SPACING STEEL PIPE THREADED LIGHTWALL
1", 1-1/4"	12'-0"	12'-0"
1-1/2", 2", 2-1/2", 3"	15'-0"	12'-0"
4", 6", 8"	15'-0"	N/A
INSTALL HANGERS IN ACCORDANCE WITH NFPA 13 AND STRUCTURAL REQUIREMENTS		

PIPE SUPPORT DETAIL
NOT TO SCALE



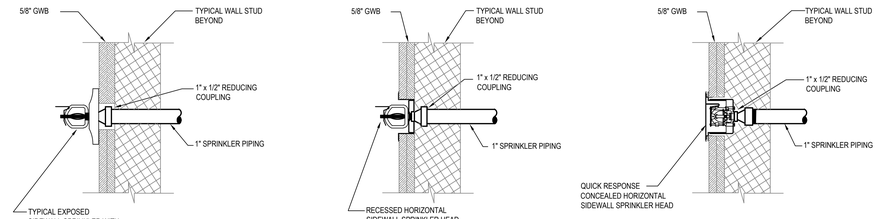
EARTHQUAKE BRACE AND SURGE RESTRAINT COMPONENTS

TOLCO FIG. 1000 FAST CLAMPS U.L. LISTED, MUST BE USED WITH TOLCO U.L. LISTED ATTACHMENTS FIG. 909 OR FIG. 910 SWIVEL FITTINGS OR FIG. 975 OR FIG. 908 STRAIGHT FITTINGS

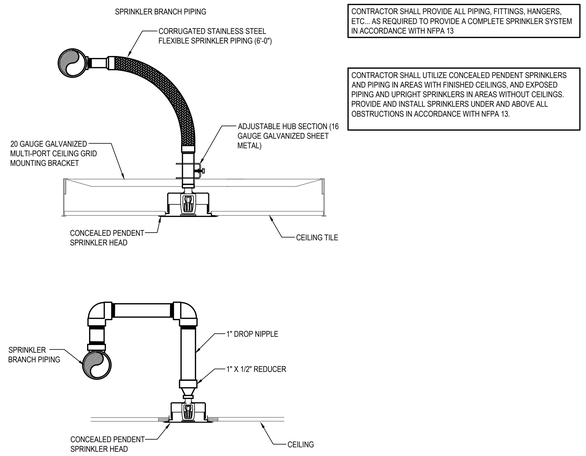


SEISMIC PIPING HANGER BRACING DETAIL
NOT TO SCALE

CONTRACTOR SHALL PROVIDE LISTED HEAD GUARDS FOR USE WITH SPRINKLERS IN AREAS SUBJECT TO MECHANICAL DAMAGE. COORDINATE AREAS WITH OWNER, PRIOR TO INSTALLATION



SIDEWALL SPRINKLER HEAD DETAILS
NOT TO SCALE



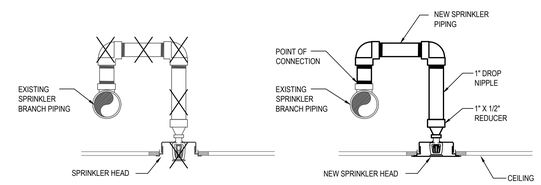
CONTRACTOR SHALL PROVIDE ALL PIPING, FITTINGS, HANGERS, ETC... AS REQUIRED TO PROVIDE A COMPLETE SPRINKLER SYSTEM IN ACCORDANCE WITH NFPA 13

CONTRACTOR SHALL UTILIZE CONCEALED PENDENT SPRINKLERS AND PIPING IN AREAS WITH FINISHED CEILINGS, AND EXPOSED PIPING AND UPRIGHT SPRINKLERS IN AREAS WITHOUT CEILINGS. PROVIDE AND INSTALL SPRINKLERS UNDER AND ABOVE ALL OBSTRUCTIONS IN ACCORDANCE WITH NFPA 13.

CONCEALED PENDENT SPRINKLER HEAD DETAILS
NOT TO SCALE

CONTRACTOR SHALL PROVIDE ALL PIPING, FITTINGS, HANGERS, ETC. AS REQUIRED TO PROVIDE A COMPLETE SPRINKLER SYSTEM IN ACCORDANCE WITH FM GLOBAL AND NFPA 13

PROVIDE AND INSTALL SPRINKLERS UNDER AND ABOVE ALL OBSTRUCTIONS IN ACCORDANCE WITH NFPA 13.



SPRINKLER HEAD DETAILS
NOT TO SCALE

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
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Trumbull, CT 06611

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Drawing Title:
SCHEDULES AND DETAILS
State Project #144-_ _ _ _ _ _

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PLUMBING GENERAL NOTES

GENERAL

THE INTENT OF THESE CONTRACT DOCUMENTS (SPECIFICATIONS AND DRAWINGS) IS FOR THE CONTRACTOR TO FURNISH AND INSTALL COMPLETE PLUMBING SYSTEMS. ALL SYSTEMS SHALL BE COMPLETE IN ALL RESPECTS. OPERATING, TESTED, ADJUSTED, APPROVED BY THE AUTHORITIES HAVING JURISDICTION AND READY FOR BENEFICIAL USE BY THE OWNER.

WHEN A CONFLICT BETWEEN THE DRAWINGS, NOTES AND/OR SPECIFICATIONS OCCUR, THE MORE STRINGENT, AND/OR LARGER QUANTITY AND/OR MORE EXPENSIVE SHALL APPLY. THE REQUIREMENTS LISTED WITHIN NOTES OR SPECIFICATIONS SHALL BE REQUIRED, PROVIDED AND INSTALLED WHETHER SPECIFICALLY INDICATED ON THE DRAWINGS OR NOT.

ITEMS AND SERVICES NOT SHOWN ON DRAWINGS OR SPECIFICATIONS BUT REQUIRED TO RENDER THE WORK COMPLETE AND READY FOR OPERATION, SHALL BE PROVIDED WITHOUT ADDITIONAL COST.

WORK OF THIS SECTION SHALL BE GOVERNED BY THE CONTRACT DOCUMENTS. PROVIDE MATERIALS, LABOR, EQUIPMENT AND SERVICES NECESSARY TO FURNISH, DELIVER AND INSTALL ALL WORK AS SPECIFIED AND AS REQUIRED BY JOB CONDITIONS. WHERE A CONFLICT EXISTS BETWEEN THESE NOTES, THE DRAWINGS AND THE SPECIFICATIONS, THE MORE STRINGENT REQUIREMENT SHALL APPLY.

DRAWINGS ARE DIAGRAMMATIC AND INDICATE A GENERAL ARRANGEMENT OF WORK AND ARE NOT TO BE CONSIDERED SUB-CONTRACTOR DOCUMENTS. IT IS THE INTENT OF THESE DOCUMENTS TO INCLUDE THE PROVISION AND INSTALLATION OF ALL NECESSARY WORK AND MATERIALS FOR COMPLETE, OPERATIONAL AND CODE COMPLIANT SYSTEMS BY THE CONTRACTOR. GENERAL DESIGN CONCEPTS INDICATED MUST BE FOLLOWED OR BETTERED. THE BID SHALL INCLUDE OFFSETS, ADDITIONAL PIPING, VALVES AND EQUIPMENT AND COMPONENTS AS REQUIRED TO MEET CONSTRUCTION CONDITIONS FOR PROPER OPERATION. DO NOT SCALE DRAWINGS. CONSULT ARCHITECTURAL AND STRUCTURAL DRAWINGS FOR SPACE CONDITIONS AND ADDITIONAL REQUIREMENTS.

PERFORM THE WORK IN ACCORDANCE WITH THE REQUIREMENTS OF THE CONTRACT GENERAL CONDITIONS AND WITH THE PROVISIONS OF ALL APPLICABLE LOCAL, STATE, AND FEDERAL CODES AND LAWS.

WORK SHALL INCLUDE ALL INCIDENTALS, LABOR, MATERIAL, EQUIPMENT, APPLIANCES, SERVICES, HOISTING, SCAFFOLDING, SUPPORTS, TOOLS, CONSUMABLE ITEMS, FEES, LICENSES, AND ADMINISTRATIVE TASKS REQUIRED TO COMPLETE AND MAKE OPERABLE WORK SHOWN ON THE DRAWINGS, SPECIFIED HEREIN AND AS REQUIRED FOR A COMPLETE AND OPERATIONAL SYSTEM..

ALL EQUIPMENT, MATERIALS AND RELATED SYSTEMS COMPONENTS SHALL BE NEW UNLESS SPECIFICALLY NOTED OTHERWISE.

STORE MATERIALS INSIDE AND PROTECTED FROM DEBRIS, WEATHER AND MOISTURE.

THIS CONTRACTOR SHALL COORDINATE ALL POWER AND CONTROL WIRING REQUIRED FOR EQUIPMENT OPERATION REQUIRED FOR A COMPLETE AND OPERATIONAL SYSTEM WITH ELECTRICAL CONTRACTOR. THIS CONTRACTOR SHALL PROVIDE MOTOR STARTERS FOR INSTALLATION. COORDINATE REQUIREMENTS.

PROVIDE AND INSTALL ALL MAKE-UP WATER DISTRIBUTION TO HVAC EQUIPMENT INCLUDING BACKFLOW PREVENTER.

PROVIDE AND INSTALL INDIRECT CONDENSATE WASTE PIPING AND TRAP TO FLOOR DRAIN OR DRAIN RECEPTOR FROM ALL HVAC EQUIPMENT. PROVIDE ADDITIONAL FLOOR DRAINS WITH TRAP PRIMERS OR DRAIN RECEPTORS AS REQUIRED.

PLUMBING DEVICES, FAUCETS, VALVES AND FITTINGS REQUIRED FOR SPECIALTY SERVICE EQUIPMENT (IE. KITCHEN, LAB,ETC) SHALL BE PROVIDED BY THIS CONTRACTOR UNLESS OTHERWISE SPECIFIED. THIS CONTRACTOR SHALL PROVIDE AND INSTALL PIPING, CONNECTIONS, DEVICES, VALVES AND EQUIPMENT REQUIRED FOR PROPER OPERATION. COORDINATE REQUIREMENTS.

REPAIR AND/OR REPLACE AT NO COST TO OWNER ALL EQUIPMENT AND MATERIALS DAMAGED DURING CONSTRUCTION.

ALTERATION WORK AND DEMOLITION

ALL EQUIPMENT, FIXTURES, PIPING, ETC. TO BE REMOVED, SHALL BE DISPOSED OF, TURNED OVER TO THE OWNER, OR SALVAGED AS DIRECTED BY THE OWNER. EQUIPMENT, FIXTURES, PIPING, DEVICES, ETC. SHALL NOT BE REMOVED FROM THE PREMISES WITHOUT THE OWNERS APPROVAL.

UPON COMPLETION OF REMOVALS AND MODIFICATIONS, ALL PIPING TO REMAIN SHALL BE PROPERLY PLUGGED, VALVED, CAPPED AND/OR BY PASSED SUCH THAT UPON COMPLETION OF WORK ALL SYSTEMS TO REMAIN, REMAIN OPERATIONAL.

NO DEAD ENDS SHALL BE LEFT ON ANY PIPING SYSTEMS UPON COMPLETION OF WORK.

EXISTING EXPOSED PIPING SYSTEMS NOT TO BE REUSED, AND NOT SPECIFICALLY NOTED FOR REMOVAL SHALL BE COMPLETELY REMOVED.

ALL SYSTEMS SHALL BE LEFT IN WORKING ORDER TO THE SATISFACTION OF THE OWNER UPON COMPLETION OF ALL NEW WORK.

ALL EXISTING EXPOSED, UNNECESSARY PIPING RELATED TO NEW WORK SHALL BE COMPLETELY REMOVED.

RE-ROUTE OR REMOVE ALL EXISTING PIPING AND SYSTEMS WHERE NECESSARY TO AVOID NEW EQUIPMENT, STRUCTURAL, OR MASONRY WORK AS REQUIRED BY THE PROPOSED ALTERATIONS.

COORDINATION

THE CONTRACTOR SHALL OBTAIN AND REVIEW ALL CONTRACT DOCUMENTS, INCLUDING PROJECT MANUAL, PLANS AND SPECIFICATIONS OF ALL TRADES BEFORE SUBMITTING BID. REFER TO SPECIFICATIONS, PROJECT MANUAL AND PLANS, INCLUDING ALL EQUIPMENT SCHEDULES FOR INFORMATION. CONTRACTOR SHALL WALK THROUGH BUILDING PRIOR TO SUBMITTING BID WHEN AVAILABLE.

ALL OF THE CONTRACT DRAWINGS AND SPECIFICATIONS ARE COMPLIMENTARY TO FORM A TOTAL DESIGN PACKAGE. IT IS THE RESPONSIBILITY OF THE GENERAL CONTRACTOR/CONSTRUCTION MANAGER TO DETERMINE WHICH TRADE CONTRACTOR IS RESPONSIBLE FOR VARIOUS PORTIONS OF THE WORK.

ALL WORK AND ACTION DEPICTED AND DESCRIBED SHALL BE PERFORMED BY THE CONTRACTOR UNLESS SPECIFICALLY NOTED OTHERWISE.

THE PLUMBING CONTRACTOR SHALL VERIFY THESE DRAWINGS WITH EXISTING FIELD CONDITIONS AND SHALL COORDINATE WITH CIVIL ENGINEER LOCATIONS AND ELEVATIONS OF PLUMBING SERVICE LINES BEFORE PROCEEDING WITH CONSTRUCTION. THE UTILITY SERVICE LINES SHOWN ON THE DRAWINGS ARE FOR REFERENCE & BUILDING PERMIT ONLY. REFER TO CIVIL ENGINEERS DRAWINGS FOR UTILITY SERVICE LINES LAY-OUT & DETAILS.

CONTRACTORS SHALL COORDINATE THEIR WORK WITH ALL OWNER-FURNISHED EQUIPMENT, INCLUDING REQUIRED SERVICE CONNECTIONS, RECEPTACLES, ETC. BEFORE INSTALLATION.

THE DRAWINGS ARE DIAGRAMMATIC AND INDICATE THE GENERAL ARRANGEMENT OF SYSTEMS AND WORK INCLUDED IN THE CONTRACT. THE CONTRACTOR SHALL COORDINATE LOCATIONS OF EQUIPMENT WITH ALL TRADES BEFORE STARTING CONSTRUCTION. ANY MODIFICATIONS TO THE EQUIPMENT LAYOUT REQUIRED FOR INSTALLATION ARE TO BE PERFORMED AT NO ADDITIONAL COST TO THE OWNER.
COORDINATE ALL PIPING AND CONDUITS LEAVING THE BUILDING WITH THE SITE CONTRACTOR BEFORE INSTALLATION.
LOCATION AND SIZES OF ALL FLOOR, WALL AND ROOF PENETRATIONS SHALL BE COORDINATED WITH ALL OTHER TRADES INVOLVED.

DEVELOP AND SUBMIT COORDINATION DRAWINGS AS OUTLINED.

SHEET METAL, PLUMBING AND FIRE PROTECTION SHOP DRAWINGS THAT HAVE BEEN COORDINATED WITH ARCHITECTURAL AND STRUCTURAL DRAWINGS SHALL BE SUBMITTED TO ENGINEER FOR REVIEW. DRAWINGS MUST BE RETURNED FROM ENGINEER EITHER "REVIEWED" OR "FURNISH AS CORRECTED" PRIOR TO BEING USED AS BASIS FOR COORDINATION DRAWINGS.

AFTER SHEET METAL AND PIPING DRAWINGS HAVE BEEN REVISED PER ENGINEERS COMMENTS, REPRODUCIBLE COPIES SHALL BE SENT TO THE TRADES IN THE FOLLOWING SEQUENCE FOR THE INCLUSION OF THEIR WORK:

-MECHANICAL SHEET METAL
-PLUMBING PIPING
-MECHANICAL PIPING
-SPRINKLER PIPING
-ELECTRICAL WORK

AFTER ALL TRADES HAVE INCLUDED THEIR WORK ON THE COORDINATION DRAWING AND NOTED CONFLICTS, ALL TRADES SHALL MEET TO RESOLVE CONFLICTS AND AGREE TO ACCEPTABLE SOLUTIONS. EACH TRADE SHALL SIGN COORDINATION DRAWINGS. ITEMS NOT SHOWN ON COORDINATION DRAWING IS RESPONSIBILITY OF OMITTING CONTRACTOR AND CONTRACTOR IS SUBJECT TO ADDITIONAL COSTS INCURRED BY OTHER TRADES.

THE ARCHITECT AND ENGINEER ARE NOT PART OF THE COORDINATION DRAWING PROCESS. THE ENGINEER WILL PROVIDE ASSISTANCE FOR NOTED CONFLICTS ONLY. COORDINATION DRAWINGS ARE NOT TO BE CONSIDERED PIPING OR DUCT SHOP DRAWINGS. THE CONTRACTOR IS REQUIRED TO SUBMIT INDIVIDUAL PIPING AND DUCTWORK SHOP DRAWINGS FOR REVIEW BY THE ENGINEER. PIPING AND DUCTWORK SHOP DRAWINGS SHALL FOLLOW THE DESIGN INTENT OF THE CONTRACT DOCUMENTS.

SUBMIT FINAL SIGNED COORDINATION DRAWING TO ENGINEER FOR REVIEW. ENGINEER WILL REVIEW COORDINATION DRAWINGS FOR GENERAL ARRANGEMENT AND FOR NOTED CONFLICTS ONLY. SPECIFIC INSTALLATION REQUIREMENTS WILL BE REVIEWED ONLY IN INDIVIDUAL TRADE SHOP DRAWINGS.

ANY WORK FABRICATED OR INSTALLED PRIOR TO SIGN OFF BY ALL TRADES WHICH IS DEEMED TO BE IN CONFLICT WITH COORDINATION DRAWINGS SHALL BE REMOVED AND RE-INSTALLED IN CONFORMANCE WITH COORDINATION DRAWINGS.

EACH CONTRACTOR (MENTIONED ABOVE) IS RESPONSIBLE FOR THE COORDINATION OF HIS SUB-CONTRACTORS.

THE OVERALL COORDINATION OF THE COORDINATION PROCESS IS THE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER IS NOT RESPONSIBLE FOR THE COORDINATION PROCESS. THE ENGINEER WILL RESPOND TO QUESTIONS THAT ARISE FROM THE COORDINATION PROCESS. DRAWINGS SUBMITTED WILL BE REVIEWED FOR CLEARLY IDENTIFIED CONFLICTS ONLY. SOLUTIONS TO CONFLICTS WILL NOT BEAR ADDITIONAL COST.

SHOP DRAWINGS

CONTRACTOR SHALL SUBMIT SHOP DRAWINGS TO BE APPROVED, REVISED, OR RESUBMITTED AS PER THE ENGINEERS COMMENTS, PRIOR TO CONSTRUCTION. INCLUDING BUT NOT LIMITED TO THE FOLLOWING:

-CLEAN OUTS -DRAINS -PIPING
-PIPE SEALS -FITTINGS -BRAZING
-HANGERS/SUPPORTS -VALVES -INSULATION

AS BUILT DRAWINGS

PROVIDE A COMPLETE SET OF AS-BUILT DRAWINGS REFLECTING AS INSTALLED CONDITIONS. AS-BUILT DRAWINGS SHALL INDICATE ALL INSTALLED CONDITIONS OF SYSTEMS WITHIN THIS DISCIPLINE. DRAWINGS SHALL BE OF SIMILAR SCALE AS THE CONSTRUCTION DOCUMENTS AND INCLUDE DETAILS AS NECESSARY TO CLEARLY REFLECT THE INSTALLED CONDITION. DRAWINGS SHALL BE BOUND IN A COMPLETE AND CONSECUTIVE SET. SUPPLEMENTAL SKETCHES AND LOOSE PAPERWORK WILL NOT BE ACCEPTABLE AND WILL BE RETURNED FOR REVISION. THE CONTRACTOR SHALL COMPLY WITH THE ENGINEERS COMMENTS TO PRODUCE A CLEAR AND CONCISE SET OF DRAWINGS. DRAWINGS SHALL BE SUBMITTED IN BOTH HARD COPY AND ELECTRONIC (AUTO-CAD VERSION AS REQUIRED BY THE OWNER) VERSION. NUMBER OF COPIES OF EACH AS REQUESTED BY THE OWNER.

PROVIDE "AS-BUILT DRAWINGS" INDICATING IN A NEAT AND ACCURATE MANNER A COMPLETE RECORD OF ALL REVISIONS OF THE ORIGINAL DESIGN OF THE WORK. INDICATE THE FOLLOWING INSTALLED CONDITIONS:

INCLUDE ALL CHANGES AND AN ACCURATE RECORD, ON REPRODUCTIONS OF THE CONTRACT DRAWINGS OR APPROPRIATE SHOP DRAWINGS, OF ALL DEVIATIONS, BETWEEN THE WORK SHOWN AND WORK INSTALLED.

MAINS AND BRANCHES OF PIPING SYSTEMS, WITH VALVES AND CONTROL DEVICES LOCATED AND NUMBERED, CONCEALED UNIONS LOCATED, AND WITH ITEMS REQUIRING MAINTENANCE LOCATED (I.E., TRAPS, STRAINERS, EXPANSION COMPENSATORS, TANKS, ETC.). VALVE LOCATION DIAGRAMS, COMPLETE WITH VALVE TAG CHART.
EQUIPMENT LOCATIONS (EXPOSED AND CONCEALED), DIMENSIONED FROM PROMINENT BUILDING LINES.

APPROVED SUBSTITUTIONS, CONTRACT MODIFICATIONS, AND ACTUAL EQUIPMENT AND MATERIALS INSTALLED.

CONTRACT MODIFICATIONS, ACTUAL EQUIPMENT AND MATERIALS INSTALLED.

SUBMIT FOR REVIEW BOUND SETS OF THE REQUIRED DRAWINGS, MANUALS AND OPERATING INSTRUCTIONS.

SUBMIT A COMPLETE MAINTENANCE MANUAL OF ALL EQUIPMENT INSTALLED UNDER THIS CONTRACT.

HOUSEKEEPING PADS

PROVIDE CONCRETE HOUSEKEEPING PADS FOR FLOOR-MOUNTED EQUIPMENT. COORDINATE EXACT LOCATIONS, DIMENSIONS, PIPING LOCATIONS, AND ANCHOR BOLT REQUIREMENTS. PROVIDE CONCRETE HOUSEKEEPING PADS UNDER ALL FLOOR MOUNTED EQUIPMENT. PADS SHALL BE CONSTRUCTED OF 3,000 PSI CONCRETE. PADS SHALL BE 4 INCHES HIGH, AND 4 INCHES WIDER THAN THE EQUIPMENT IN BOTH DIRECTIONS.

COORDINATE FLOOR DRAIN LOCATIONS WITH RESPECT TO EQUIPMENT HOUSEKEEPING PADS. PLACE DRAINS SUCH THAT EDGE OF THE FLOOR GRATE EXTENDS NO FURTHER THAN 2 INCHES FROM THE SIDE OF THE PAD.

HANGERS AND SUPPORT

SEISMIC RESTRAINT: PROVIDE SEISMIC RESTRAINT AND EXPANSION OF ALL PLUMBING EQUIPMENT AND SYSTEMS IN ACCORDANCE WITH STATE AND FEDERAL BUILDING CODE REQUIREMENTS. SUBMIT SHOP DRAWINGS SIGNED AND SEALED BY A LICENSED PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF THE PROJECT INDICATING ALL NECESSARY COMPONENT CUTS, PLAN LOCATIONS AND CALCULATIONS FOR A COMPLETE SYSTEM.

PROVIDE ALL NECESSARY STRUCTURAL MEMBERS INCLUDING ADDITIONAL STRUCTURAL SUPPORT TO SUPPORT PIPING AND EQUIPMENT. HANGERS AND SUPPORTS SHALL BE OF AN APPROVED DESIGN NECESSARY TO SUPPORT PIPING, EQUIPMENT AND TO KEEP PIPING IN PROPER ALIGNMENT AND PREVENT TRANSMISSION OF INJURIOUS THRUSTS AND VIBRATIONS. IN ALL CASES WHERE HANGERS, BRACKETS, ETC., ARE SUPPORTED FROM CONCRETE CONSTRUCTION, DO NOT WEAKEN CONCRETE OR PENETRATE WATERPROOFING. ALL HANGERS AND SUPPORTS SHALL BE CAPABLE OF SCREW ADJUSTMENT AFTER PIPING IS ERECTED. HANGERS SUPPORTING PIPING EXPANDING INTO LOOPS, BENDS AND OFFSETS SHALL BE SECURED TO THE BUILDING STRUCTURE IN SUCH A MANNER THAT HORIZONTAL ADJUSTMENT PERPENDICULAR TO THE RUN OF PIPING SUPPORTED MAY BE MADE TO ACCOMMODATE DISPLACEMENT DUE TO EXPANSION. ALL SUCH HANGERS SHALL BE FINALLY ADJUSTED BOTH IN THE VERTICAL AND HORIZONTAL DIRECTION, AS REQUIRED. HANGERS IN CONTACT WITH COPPER OR BRASS PIPE SHALL BE DIELECTRIC, COMPATIBLE WITH COPPER AND BRASS ALLOY OR PROVIDED WITH FELT SLEEVE.

PROVIDE ADDITIONAL SUPPORT FOR PIPING AND EQUIPMENT WHEN DECK IS NOT CAPABLE OF SUPPORT.

BEAM CLAMPS - HANGERS SUPPORTED FROM STEEL SHALL BE CENTER LOADING BEAM CLAMPS FOR HANGERS SUPPORTING PIPING 2 INCHES. FOR PIPING 2-1/2 INCHES AND LARGER, I BEAM CLAMPS SHALL BE FORGED STEEL "C" CLAMPS ARE NOT TO BE USED.

PROVIDE AND INSTALL EXPANSION COMPENSATION FOR ALL PIPING. SUBMIT PLANS, CALCULATIONS AND EQUIPMENT DATA.

BAND IRON, TIE WIRE, METAL STRAPPING OR WIRE STRAPPING SHALL NOT BE PERMITTED TO SUPPORT PIPING OR EQUIPMENT.

PIPE SEALS

SEAL ALL PIPING PASSING THROUGH ALL FIRE AND/OR SMOKE RATED PARTITIONS AND WALLS WITH A UL LISTED, APPROVED AND TESTED FIRE AND/OR SMOKE SEALING MATERIAL INSTALLED IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.

ALL PIPING PENETRATING A SLAB ON GRADE OR FOUNDATION WALL BELOW GRADE AND IN CONTACT WITH EARTH SHALL BE PROVIDED WITH A POURED IN PLACE SCHEDULE 80 GALVANIZED STEEL WATER TIGHT SLEEVE WITH INTEGRAL WATER STOP AND SEAL EQUAL TO "LINK SEAL".

FURNISH AND SET STEEL PIPE SLEEVES OF SCHEDULE 40 BLACK STEEL FOR ALL LOCATIONS OF INTERIOR PARTITIONS, WALLS AND FLOORS PROVIDING AT LEAST 1/2" CLEARANCE BETWEEN PIPE INSULATION AND SLEEVE OR PIPE AND SLEEVE. WALL SLEEVES SHALL BE SMOOTH CUT AND SET FLUSH WITH FINISHED WALLS. FLOOR SLEEVES SHALL EXTENDED 2" ABOVE THE FINISHED FLOOR.

ALL PIPING THROUGH WALLS, FLOORS OR CEILINGS SHALL HAVE SLEEVES AND ESCUTCHEONS. PROVIDE A TWO PIECE CHROME ESCUTCHEON WHERE PIPING PASSES THROUGH WALLS OR FLOORS OF FINISHED SPACES.

DRAINS AND CLEANOUTS

CONCEALED PIPING. CLEANOUTS ON CONCEALED PIPING OR PIPING UNDER A FLOOR SLAB OR IN A CRAWL SPACE OF LESS THAN 24 INCHES IN HEIGHT OR A PLENUM SHALL BE EXTENDED THROUGH AND TERMINATE FLUSH WITH THE FINISHED WALL, FLOOR OR GROUND SURFACE OR SHALL BE EXTENDED TO THE OUTSIDE OF THE BUILDING. CLEANOUT PLUGS SHALL NOT BE COVERED WITH CEMENT, PLASTER OR ANY OTHER PERMANENT FINISH MATERIAL. WHERE IT IS NECESSARY TO CONCEAL A CLEANOUT OR TO TERMINATE A CLEANOUT IN AN AREA SUBJECT TO VEHICULAR TRAFFIC, THE COVERING PLATE, ACCESS DOOR OR CLEANOUT SHALL BE OF AN APPROVED TYPE DESIGNED AND INSTALLED FOR THIS PURPOSE.

MINIMUM SIZE. CLEANOUTS SHALL BE THE SAME NOMINAL SIZE AS THE PIPE THEY SERVE UP TO 4 INCHES. FOR PIPES LARGER THAN 4 INCHES NOMINAL SIZE, THE MINIMUM SIZE OF THE CLEANOUT SHALL BE 4 INCHES.

ACCESS SHALL BE PROVIDED TO ALL CLEANOUTS.

PROVIDE CONDENSATE DRAINAGE, COMPLETE WITH CONDENSATE REMOVAL PUMP, FOR EACH COOLING COIL. CONDENSATE PUMP DISCHARGE SHALL BE CONNECTED VIA INDIRECT WASTE CONNECTION TO BUILDING SANITARY/WASTE OR STORM PIPING SYSTEM. COORDINATE PUMP WIRING WITH PROJECT ELECTRICIAN. IF GRAVITY DRAINAGE IS POSSIBLE WITHIN THE CONSTRAINTS OF PIPING PITCH, CONCEALMENT ABOVE CEILINGS, AND ONLY AFTER COMPLETE COORDINATION WITH STRUCTURE AND OTHER TRADES, THE CONTRACTOR MAY SUBMIT SKETCH PROPOSALS FOR GRAVITY ROUTING FOR REVIEW/APPROVAL.

MISCELLANEOUS SPECIALTIES

ALL EQUIPMENT, VALVES, STRAINERS, UNIONS, TRAPS, FLANGES AND OTHER APPURTENANCES REQUIRING ACCESS SHALL BE LOCATED IN ACCESSIBLE LOCATIONS. WHEN A PIECE OF EQUIPMENT MUST BE LOCATED ABOVE AN INACCESSIBLE CEILING OR WALL THEN THE APPROPRIATE ACCESS DOOR SHALL BE PROVIDED. SUCH EQUIPMENT INCLUDES, BUT IS NOT LIMITED TO CLEANOUTS, WATER HAMMER ARRESTORS AND VALVES. THESE SHALL BE COORDINATED WITH THE ARCHITECT. ACCESS DOORS SHALL BE RIGID CONSTRUCTION WITH TWO HINGES AND A LATCH. IN PLENUM CEILINGS, PROVIDE FELT BETWEEN THE DOOR AND FRAME TO MAKE AN AIR TIGHT SEAL. ACCESS DOORS SHALL BE RATED TO THE SAME OR GREATER RATING OF THE PARTITION IN WHICH THEY ARE INSTALLED. ACCESS DOORS SHALL BE FLUSH MOUNTED, PRIME COATED WITH RUST INHIBITIVE PAINT, CONCEALED FRAME, FLUSH SCREW DRIVER OPERATED LOCKS WITH METAL CAMS AND ANCHORS AS REQUIRED.

ACCESS DOOR SIZES SHALL BE:
12" X 12" AT EASILY ACCESSIBLE ITEMS
16" X 16" WHERE PARTIAL BODY ACCESS IS REQUIRED
24" X 24" WHERE FULL BODY ACCESS IS REQUIRED

PROVIDE FLEXIBLE CONNECTIONS IN ALL PIPING SYSTEMS CONNECTED TO PUMPS AND OTHER EQUIPMENT WHICH REQUIRES VIBRATION ISOLATION, EXCEPT WATER COILS. FLEXIBLE CONNECTIONS SHALL BE PROVIDED AS CLOSE TO THE EQUIPMENT AS POSSIBLE.

INSULATION

REFER TO SCHEDULE ON DRAWING.

ALL INSULATING MATERIALS SHALL COMPLY WITH THE FOLLOWING RATINGS:

FLAME SPREAD -25
SMOKE DEVELOPED -50
FUEL CONTRIBUTED -50

FIBERGLASS PIPING INSULATION (INTERIOR)
MOLDED FIBROUS GLASS WITH 3.5 POUNDS MINIMUM DENSITY, MAXIMUM K = .3 AT 200 DEGREE F, MEAN AND RATED TO 450 DEGREE F. THE INSULATION SHOULD BE SECTIONAL PIPE JACKETED WITH AN EMBOSSED VAPOR BARRIER LAMINATE.

MANUFACTURERS:

OWENS-CORNING, TYPE 25 ASJ
KNAUF - PIPE INSULATION WITH ASJ
CERTAINTEED - TYPE 500 SNAP-ON WITH ASJ
MANVILLE - MICRO-LOK 650 WITH AP JACKET

D.TYPE G - FIBERGLASS INSULATION FOR VALVES, FITTINGS, FLANGES (VAPOR SEAL INSULATION).

MOLDED, FACTORY-FORMED FIBROUS GLASS WITH 3.5 PCF MINIMUM DENSITY, MAX. K = .3 AT 200F, MEAN, RATED TO 450 DEGREE F. ALL JOINTS TO BE SEALED WITH VAPOR BARRIER ADHESIVE AND WRAPPED WITH GLASS MESH TAPE. EACH FITTING TO BE FINISHED WITH TWO COATS OF BENJAMIN FOSTER 30-36 VAPOR SEAL.

PIPING GENERAL

NO PIPING SHALL BE COVERED UNTIL TESTED APPROVED BY THE AUTHORITIES HAVING JURISDICTION.

ALL PIPING SHALL BE RUN PERPENDICULAR AND/OR PARALLEL TO FLOORS, INTERIOR WALLS, ETC. PIPING AND VALVES SHALL BE GROUPED NEATLY AND SHALL BE RUN AS TO MAXIMIZE HEADROOM OR PASSAGE CLEARANCE. ALL VALVES, CONTROLS AND ACCESSORIES CONCEALED IN FURRED SPACES AND REQUIRING ACCESS FOR OPERATION AND MAINTENANCE SHALL BE ARRANGED TO ASSURE THE USE OF A MINIMUM NUMBER OF ACCESS DOORS.

ALL PIPE LINES MADE WITH SCREWED FITTINGS MUST BE PROVIDED WITH A SUFFICIENT NUMBER OF FLANGES AND/OR UNIONS TO ALLOW FOR EASY AND CONVENIENT DISMANTLING OF THE SYSTEM WITHOUT BREAKING FITTINGS.

ALL PIPING SHALL RUN CONCEALED IN FURRED SPACES OF OCCUPIED AREAS OR CHASES. CONTRACTOR SHALL OBTAIN PERMISSION TO RUN ANY EXPOSED PIPES.

CAP ALL PIPE AND EQUIPMENT OUTLETS DURING CONSTRUCTION AND KEEP LINES AND INSIDE OF EQUIPMENT FREE OF FOREIGN MATERIALS.

PROVIDE FOR EXPANSION WITHOUT WARPING OR DISLOCATING LINES OR STRAINING CONNECTED EQUIPMENT. INSTALL PIPING TO CLEAR BUILDING CONSTRUCTION AND TO AVOID INTERFERENCE WITH OTHER WORK. THE CONTRACTOR SHALL PROVIDE AND INSTALL COMPLETE PIPING EXPANSION SYSTEM (INCLUDING SEISMIC JOINT EXPANSION) AND DEVICES AS REQUIRED FOR PROPER EXPANSION COMPENSATION STAMPED BY A PROFESSIONAL ENGINEER LICENSED IN THE STATE OF THE PROJECT.

THE DRAWINGS INDICATE SCHEMATICALLY THE SIZE AND LOCATION OF PIPING. PIPING SHALL BE SET UP AND DOWN AND OFFSET AS REQUIRED TO MEET CONSTRUCTION CONDITIONS.

THIS CONTRACTOR SHALL INFORM HIMSELF FROM THE GENERAL CONSTRUCTION SPECIFICATIONS AND PLANS, OF THE EXACT DIMENSION OF FINISHED WORK AND OF THE HEIGHT OF FINISHED CEILINGS IN ALL ROOMS WHERE EQUIPMENT OR PIPES ARE TO BE PLACED AND ARRANGE HIS WORK IN ACCORDANCE WITH THE SCHEDULE OF INTERIOR FINISHES, AS INDICATED ON THE ARCHITECTURAL DRAWINGS.

WATER PIPING SHALL BE RUN FREE OF TRAPS AND UNNECESSARY BENDS. ANY TRAPS FORMED SHALL BE PROVIDED WITH HOSE END DRAIN VALVES WITH THREADED CAP AND CHAIN TO COMPLETELY DRAIN THE SYSTEM.

PROVIDE SECTION CUT-OFF VALVES ON ALL MAINS AND BRANCHES. PITCH AND VALVE ALL WATER PIPING FOR CONVENIENT DRAINAGE.

UNIONS AND/OR FLANGES SHALL BE INSTALLED AT EACH PIECE OF EQUIPMENT, IN BYPASSES AND IN LONG PIPING RUNS (100 FEET OR MORE) TO PERMIT DISASSEMBLY FOR ALTERATION AND REPAIRS.

WHEREVER DISSIMILAR METALS ARE JOINED TOGETHER AN APPROVED DIELECTRIC FITTING SHALL BE USED. THE DIELECTRIC FITTING SHALL BE A LISTED ASSEMBLY.

RUN ALL SOIL, WASTE AND VENT PIPING SHOWN OR REQUIRED BY LOCAL CODES. PIPING SHOWN IS MINIMUM AND IN ACCORDANCE WITH STATE AND FEDERAL CODES. IF LOCAL CODES REQUIRE ADDITIONAL VENTING OR LARGER SIZES, PROVIDE AS REQUIRED.

MAKE ALL CONNECTIONS THROUGH TRAPS. EACH TRAP TO BE VENTED, EITHER BY CIRCUIT, LOOP, OR INDIVIDUAL VENT, AS REQUIRED, BUT NOT LESS THAN SHOWN, OR AS REQUIRED BY LOCAL CODE.

GAS PIPING

INSTALL GAS PIPING, AND GAS PIPING SPECIALTIES IN ACCORDANCE WITH NFPA 54, AND AUTHORITIES HAVING JURISDICTION.

PROVIDE AND INSTALL INDEPENDENT GAS PRESSURE REGULATOR VENTS TO THE EXTERIOR AS REQUIRED IN NFPA 54 AND THE REGULATOR MANUFACTURERS REQUIREMENTS.

LOCATE GAS PIPING WITH ADEQUATE SEPARATION BETWEEN ELECTRICAL CABLES, EQUIPMENT, AND CONDUIT.

SLOPE GAS PIPING TO LOW POINTS WITHOUT TRAPS. PROVIDE DRIPS (PIPE TEE, NIPPLE, AND CAP) AT BOTTOM OF ALL VERTICAL RISERS AND DROPS.

MAKE BRANCH CONNECTIONS TO MAINS FROM TOP OR SIDE, NOT FROM BOTTOM OF MAIN.

PROVIDE AND INSTALL GAS SHUT-OFF VALVES FOR THE PROPER AND SAFE CONTROL OF THE SYSTEM.

DO NOT LOCATE GAS VALVES IN SPACES USED AS AIR PLENUMS.

VERIFICATION: BEFORE MAKING A GAS CONNECTION, VERIFY THAT EQUIPMENT IS COMPATIBLE WITH THE TYPE AND PRESSURE OF GAS BEING SUPPLIED.

PURGING: PURGE GAS TO SAFE LOCATION.

PLUMBING PIPING SYSTEM LEGEND

EXISTING	NEW	DESCRIPTION
S	S	SANITARY WASTE
S	S	SANITARY WASTE BELOW SLAB
ST	ST	STORM DRAIN
G	G	NATURAL GAS
	G	FUTURE NATURAL GAS
CD	CD	CONDENSATE DRAIN

PLUMBING SYMBOL LEGEND

SYMBOL	DESCRIPTION
	BALL VALVE
	GAS VALVE
	PRESSURE RELIEF VALVE
	GATE VALVE
	SUPPLY VALVE
M	GAS METER
R	PRESSURE REGULATOR
	POINT OF NEW CONNECTION
	POINT OF DISCONNECTION
	PIPE DOWN
	PIPE UP
	CAPPED PIPE
	CLEANOUT PLUG
	UNION
	DIRECTION OF FLOW
	PIPE OR EQUIPMENT TO BE DEMOLISHED
XXX	PLUMBING FIXTURE
XXX-A	ADA COMPLIANT PLUMBING FIXTURE

PLUMBING DRAWING INDEX

SHEET	DESCRIPTION
P001	GENERAL NOTES
P110	BASEMENT/GROUND FLOOR PLAN
P111	BUILDING "B" FIRST AND SECOND PARTIAL FLOOR PLANS
P112	ROOF PLAN
P201	SCHEDULES AND DETAILS

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES
3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
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Revision: Description: Date: Revised By:

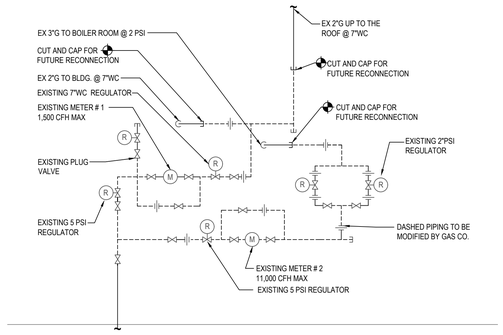
Drawing Title:
GENERAL NOTES

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: MPB
Project Number: 22.335

Drawing Number: P001

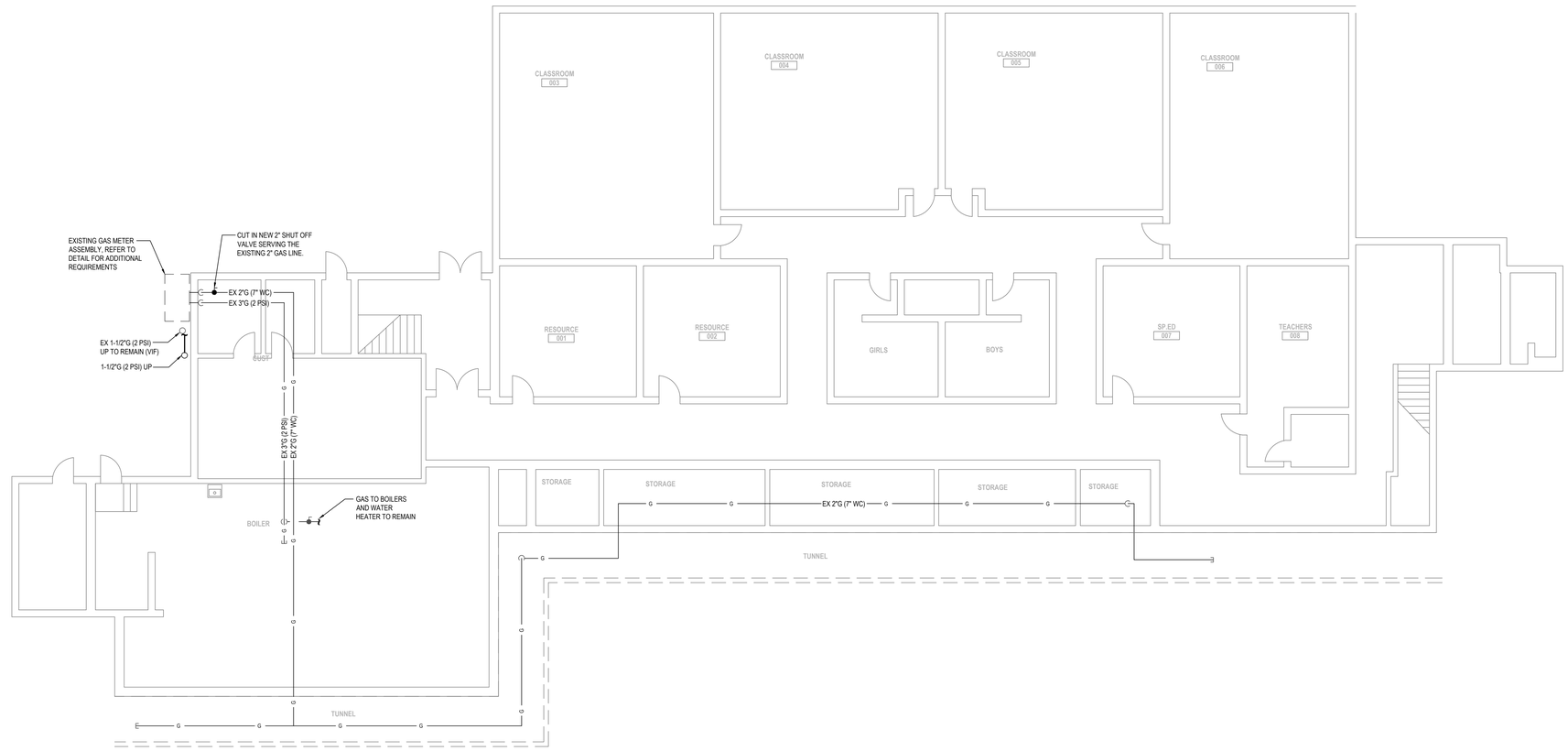
THE EXISTING GAS METER ASSEMBLY IS TO BE RECONFIGURED BY SOUTHERN CONNECTICUT GAS. METERS TO BE CONSOLIDATED INTO ONE (1) 2 PSI METER WITH TWO (2) DELIVERY PRESSURES VIA PRESSURE REGULATORS. PLUMBING CONTRACTOR TO CONNECT DOWNSTREAM OF NEW METER ASSEMBLY AND PROVIDE 7" WC PRESSURE REGULATOR TO RE-FEED EXISTING LOW PRESSURE DISTRIBUTION PIPING (INDICATED BY NOTE: "CUT AND CAP FOR FUTURE RECONNECTION"). PROVIDE NEW PIPING, FITTINGS, REGULATORS, ETC. TO CONNECT BACK TO THE RECONFIGURED METER ASSEMBLY AND CAPPED DISTRIBUTION PIPING AS REQUIRED.



2 GAS METER SECTION

SCALE: NONE

NORTH



1 GROUND/BASEMENT PLAN

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

NORTH

EXISTING TO REMAIN GAS DEMANDS

EXISTING METER #1
1,500 CFH MAX
REGULATED TO 7"WC

ROOF TOP EQUIPMENT:		
EX MAU =	400	CFH @ 6.5"WC - 14"WC
EX RTU-1 =	120	CFH @ 6.5"WC - 14"WC
EX RTU-2 =	90	CFH @ 6.5"WC - 14"WC
EX RTU-3 =	250	CFH @ 6.5"WC - 14"WC
SUB TOTAL =	*860*	*CFH @ 6.5"WC - 14"WC*
EXISTING METER #1 TOTAL =	860	CFH @ 7" WC

EXISTING METER #2
11,000 CFH MAX
REGULATED TO 2 PSI

MECHANICAL EQUIPMENT:		
EX BOILER-1 =	2,363	CFH @ 10"WC- 28"WC
EX BOILER-2 =	2,363	CFH @ 10"WC- 28"WC
EX BOILER-3 =	2,363	CFH @ 10"WC- 28"WC
SUB TOTAL =	*7,089*	*CFH @ 2 PSI*
PLUMBING EQUIPMENT:		
EX WATER HEATER =	540	CFH @ 4.5"WC-14"WC
EXISTING METER #2 TOTAL =	7,629	CFH @ 2 PSI

TOTAL EXISTING GAS DEMANDS = 8,489 CFH @ 2 PSI

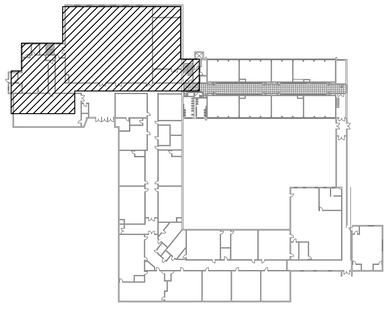
NEW GAS DEMANDS

MECHANICAL EQUIPMENT:		
DOAS-1 =	100	CFH @ 7"WC - 14"WC
DOAS-2 =	100	CFH @ 7"WC - 14"WC
DOAS-3 =	100	CFH @ 7"WC - 14"WC
DOAS-4 =	100	CFH @ 7"WC - 14"WC
ERV-T-1 =	125	CFH @ 7"WC - 14"WC
TOTAL NEW GAS DEMAND =	525	CFH @ 2 PSI

FUTURE GAS DEMANDS

MECHANICAL EQUIPMENT:		
CAF UNIT 1 =	250	CFH @ 7"WC - 14"WC
CAF UNIT 2 =	250	CFH @ 7"WC - 14"WC
GYM UNIT 1 =	250	CFH @ 7"WC - 14"WC
GYM UNIT 2 =	250	CFH @ 7"WC - 14"WC
A WING DOAS =	150	CFH @ 7"WC - 14"WC
C WING DOAS-1 =	150	CFH @ 7"WC - 14"WC
C WING DOAS-2 =	150	CFH @ 7"WC - 14"WC
TOTAL FUTURE GAS DEMAND =	1,450	CFH @ 2 PSI
TOTAL NEW + FUTURE GAS DEMAND =	1,975	CFH @ 2 PSI
COMBINED SITE GAS DEMAND =	10,464	CFH @ 2 PSI

BASEMENT KEY PLAN



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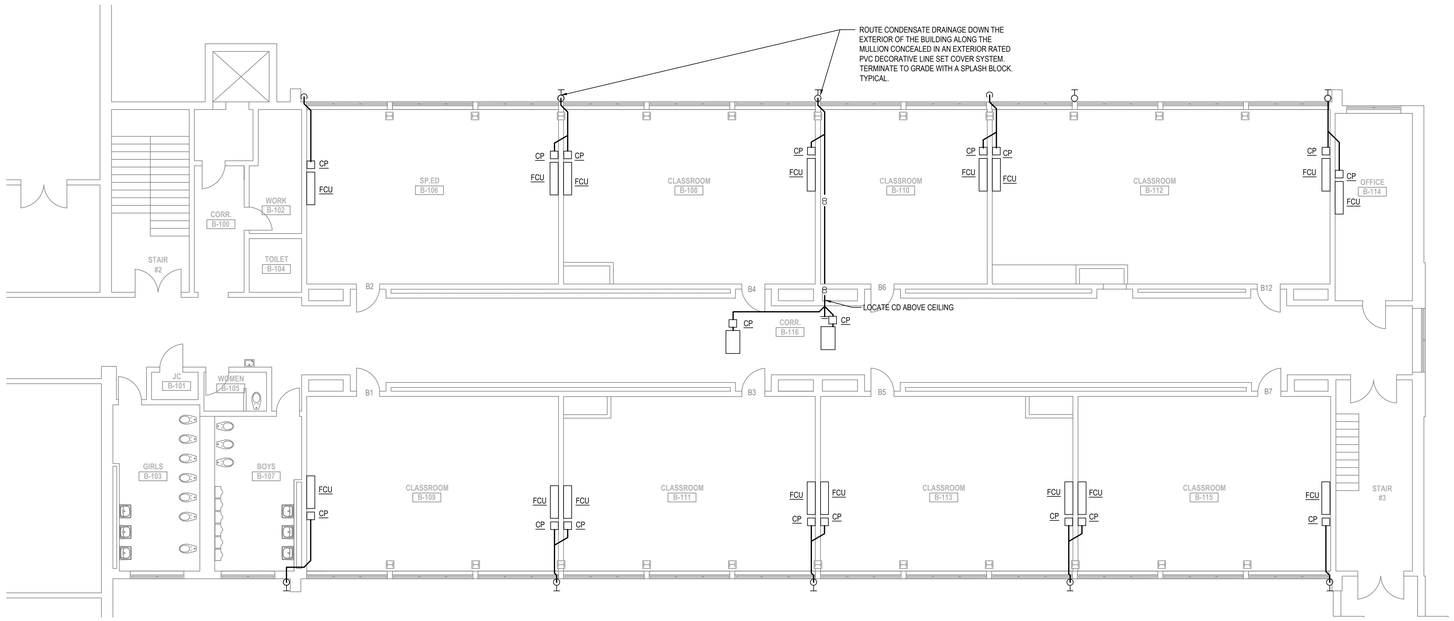
Revision:	Description:	Date:	Revised By:

Drawing Title:
BASEMENT/GROUND FLOOR PLAN

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
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Drawn By: MPB
Project Number: 22.335

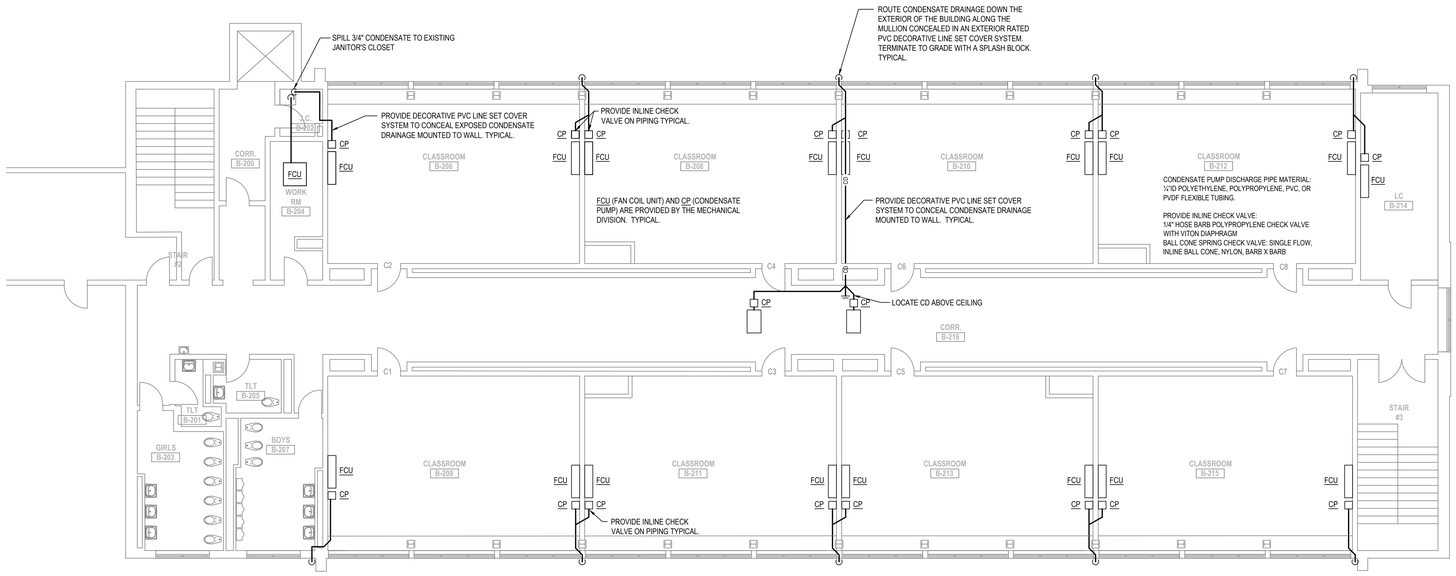
Drawing Number: P110



1 BUILDING 'B' FIRST FLOOR PARTIAL PLAN

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

NORTH

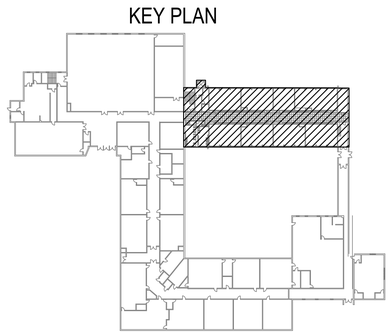


2 BUILDING 'B' SECOND FLOOR PARTIAL PLAN

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

NORTH

KEY PLAN



Project Title:

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Facilities HVAC Upgrade

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Revision:	Description:	Date:	Revised By:

Drawing Title:

BUILDING "B" FIRST AND SECOND FLOOR PARTIAL FLOOR PLANS

State Project #144-____ __

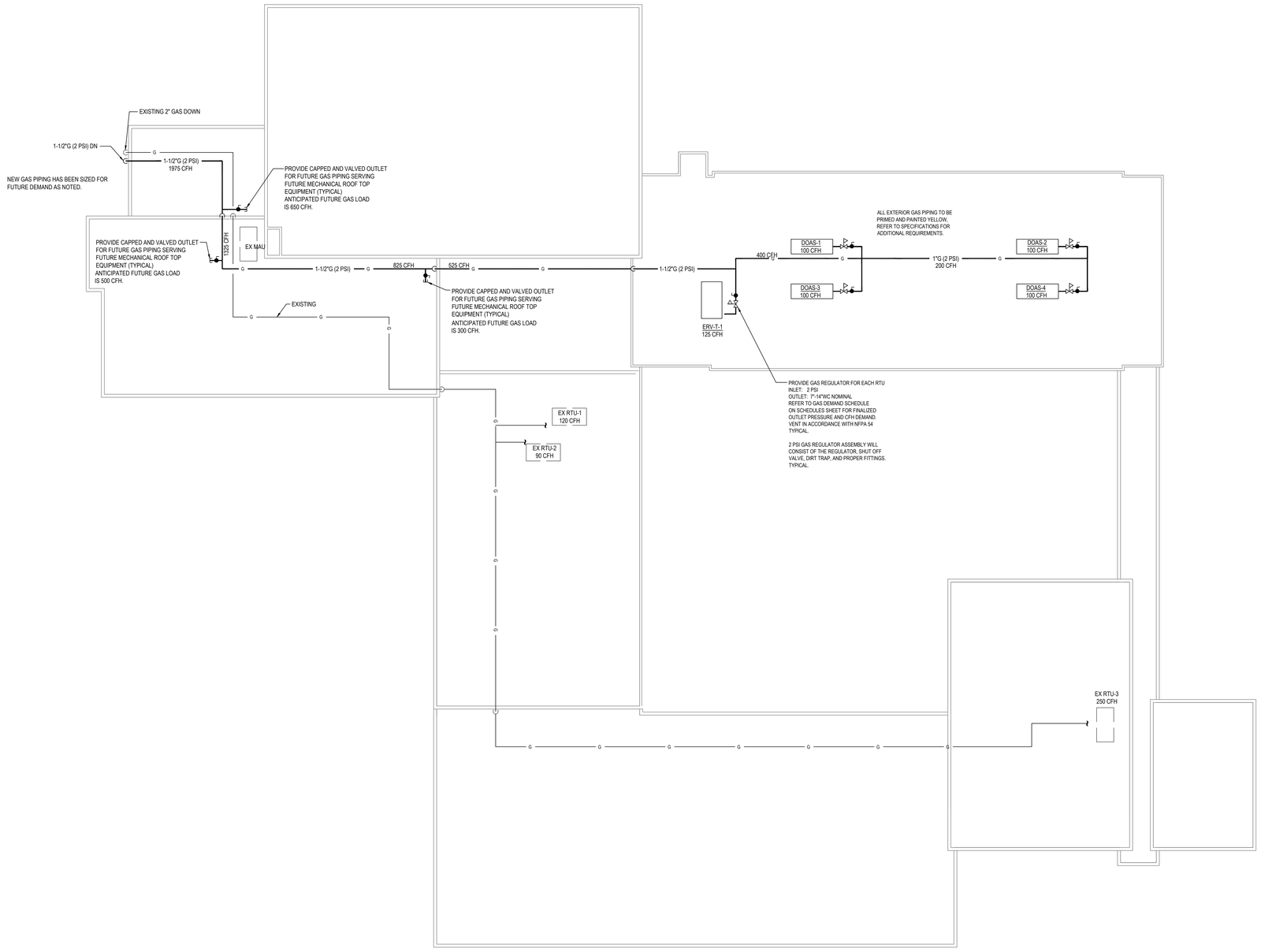
Date: 2-09-2024

Scale: AS NOTED

Drawn By: MPB

Project Number: 22.335

Drawing Number: P111



1 ROOF PLAN

SCALE: 1/16" = 1'-0"

Project Title:

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Facilities HVAC Upgrade

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Revision:	Description:	Date:	Revised By:

Drawing Title:

ROOF PLAN

State Project #144-_ _ _ _ _ _

Date: 2-09-2024

Scale: AS NOTED

Drawn By: MPB

Project Number: 22.335

Drawing Number: P112

PIPE AND FITTING SCHEDULE

DESCRIPTION	SIZE	PIPE		FITTING		REMARKS
		TYPE	SCHEDULE	TYPE	RATING	
CONDENSATE PIPING	ALL	PVC / POLY	--	--	SCH. 40	--
GAS PIPING	2" AND SMALLER	STL-BLK	SCH. 40	MIT	CLASS 150	--
GAS PIPING	2-1/2" AND LARGER	STL-BLK	SCH. 40	WE	SCH. 40	--

NOTES:
1. TRANSITION COUPLINGS AND NO-HUB PIPE SHALL NOT BE INSTALLED BELOW SLAB OR IN ANY BURIED CONDITIONS IN CONTACT WITH EARTH.
2. ALL PIPING IN RETURN AIR CEILING PLENUM INSTALLATIONS SHALL BE UL LISTED FOR THIS APPLICATION.
3. MECHANICAL JOINTS ARE ALLOWED FOR SERVICE PURPOSED ONLY IN WALLS AND CEILINGS BUT MUST BE READILY ACCESSIBLE. 25/50 PVDF IS UL LISTED FOR RETURN AIR CEILING PLENUM INSTALLATIONS.

ABBREVIATIONS	DESCRIPTION	ABBREVIATIONS	DESCRIPTION
DIMJ	DUCTILE IRON MECHANICAL JOINT	MIT	MALLEABLE IRON THREADED
GES	GROOVED END STEEL	STD	STANDARD
GJ	GROOVED JOINT SYSTEM FITTINGS/COUPLINGS	STL-BLK	BLACK STEEL
MJ	MECHANICAL JOINT	SV	SERVICE WEIGHT
WE	BUT WELD	TJ	THREADED JOINTS

VALVE SCHEDULE

DESCRIPTION	SIZE	TYPE						CLASS	REMARKS
		GATE	GLOBE	CHECK	BALL	PLUG	BALANCE		
GAS	2" AND SMALLER	--	--	--	BVT	PGVT	--	125PSI	--
GAS	2-1/2" AND LARGER	--	--	--	--	PGVF	--	125PSI	--

NOTES:
1. SOLENOID VALVE: UL LISTED, FM APPROVED FOR GAS SERVICE, EXPLOSION PROOF, TWO-WAY NORMALLY CLOSED. ASCO 8044 SERIES W/MANUAL RESET. (EMERGENCY GAS SHUT-OFF VALVE ASSEMBLY).
2. CALIBRATED PRESSURE RELIEF VALVE: INSTALL A MINIMUM OF 12" ABOVE WATER HEATER AND PIPE DISCHARGE TO ADEQUATE LOCATION. WATTS MODEL 540C.

ABBREVIATION	DESCRIPTION	ABBREVIATION	DESCRIPTION
BVF	BALL VALVE FLANGED - FULL PORT, BRONZE	PGVF	PLUG VALVE FLANGED - AGA APPROVED
BVT	BALL VALVE THREADED - 2-PIECE, FULL PORT, 400PSI, BRONZE	PGVT	PLUG VALVE THREADED - AGA APPROVED

INSULATION SCHEDULE

SYSTEM	PIPE SIZE	INSULATION TYPE	INSULATION THICKNESS	FITTINGS, VALVES, FLANGES INSULATION TYPE	REMARKS
CONDENSATE	ALL	MINERAL FIBER, ASJ, SSL	1/2"	MOLDED, PRE-FORMED MINERAL FIBER WITH PVC JACKET	FOR PIPING EXCEPT PRE-INSULATED PEX

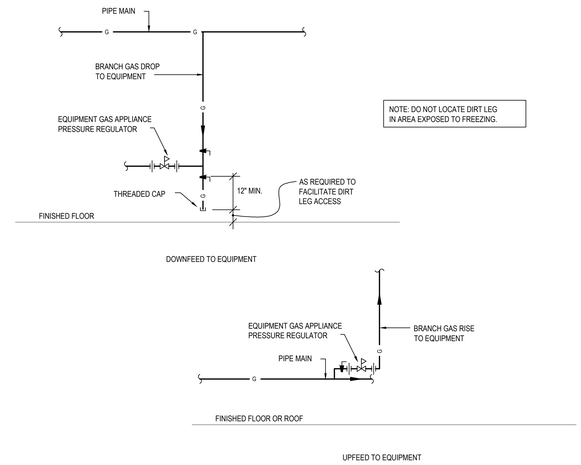
NOTES:
1. FIBERGLASS INSULATION: THERMAL CONDUCTIVITY .22 TO .28BTU x IN./H x FT x °F W/100°F MEAN TEMP. THICKNESS BASED ON ASHRAE 90.1, 1999 6.2.4.5.
2. REFER TO SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.

PIPE HANGER SPACING TABLE

PIPE MATERIAL	PIPE SIZES (INCHES)	HORIZONTAL PIPE MAX. HANGER DISTANCE (FT)	VERTICAL PIPE MAX. HANGER DISTANCE (FEET)
COPPER & COPPER ALLOY TUBING	1-1/4" & SMALLER	6'-0"	10'-0"
COPPER & COPPER ALLOY TUBING	1-1/2" & LARGER	10'-0"	10'-0"
COPPER & COPPER ALLOY PIPE	ALL	12'-0"	10'-0"
STEEL PIPE	ALL	12'-0"	15'-0"

NOTES:
* MAXIMUM HORIZONTAL SPACING OF CAST IRON PIPE HANGERS SHALL BE INCREASED TO 10'-0" WHERE 10'-" LENGTHS OF PIPE ARE USED
* * MIDSTORY GUIDE FOR SIZES 2" AND SMALLER

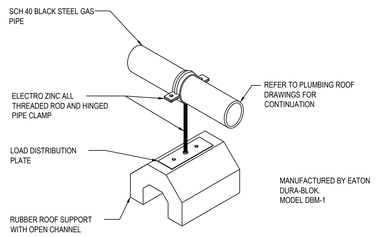
NOT ALL PIPE MATERIALS ON THIS TABLE WILL PERTAIN TO THIS PROJECT.



TYPICAL DIRT LEG DETAIL

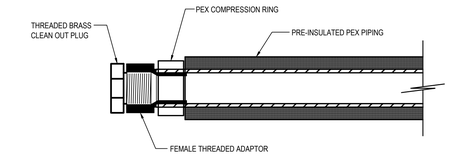
NOT TO SCALE

STEEL PIPE SIZE	SPACING OF SUPPORTS
1/2"	6 FEET
3/4" - 1"	8 FEET
1-1/2" - 2"	10 FEET



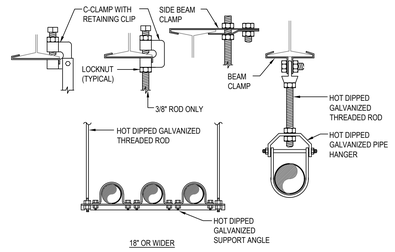
GAS ROOF TOP PIPE SUPPORT 1/2" - 2"

NOT TO SCALE



CONDENSATE CLEAN OUT DETAIL

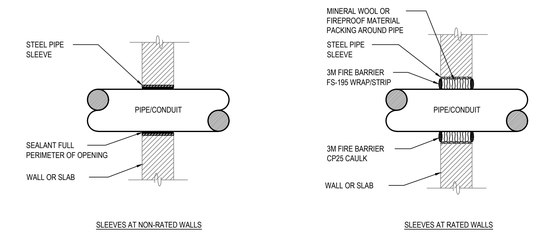
NOT TO SCALE



PIPE SIZE	MAX SPACING STEEL PIPE EXCEPT THREADED LIGHTWALL	MAX SPACING STEEL PIPE THREADED LIGHTWALL
1", 1-/4"	12'-0"	12'-0"
1-1/2", 2", 2-1/2", 3"	15'-0"	12'-0"
4", 6", 8"	15'-0"	N/A
INSTALL HANGERS IN ACCORDANCE WITH NFPA 13 AND STRUCTURAL REQUIREMENTS		

PIPE SUPPORT DETAIL

NOT TO SCALE



GENERAL NOTES:

PROVIDE UL LISTED, FM APPROVED FIRE/SMOKE PENETRATION ASSEMBLIES IN ACCORDANCE WITH UL1479, ASTM E184 REQUIREMENTS FIR WALL TYPE, RATING AND PIPE SIZES.

FIRESTOPPING SHALL HAVE A RATING EQUAL TO OR GREATER THAN THE WALL BEING PENETRATED. REFER TO ARCHITECTURAL DRAWINGS FOR WALL RATINGS.

FOR WALL PENETRATIONS AT RATED WALLS SEE SPECIFICATION SECTIONS "SEALANTS" AND "FIRESTOPPING"

PIPE PENETRATION DETAIL

NOT TO SCALE

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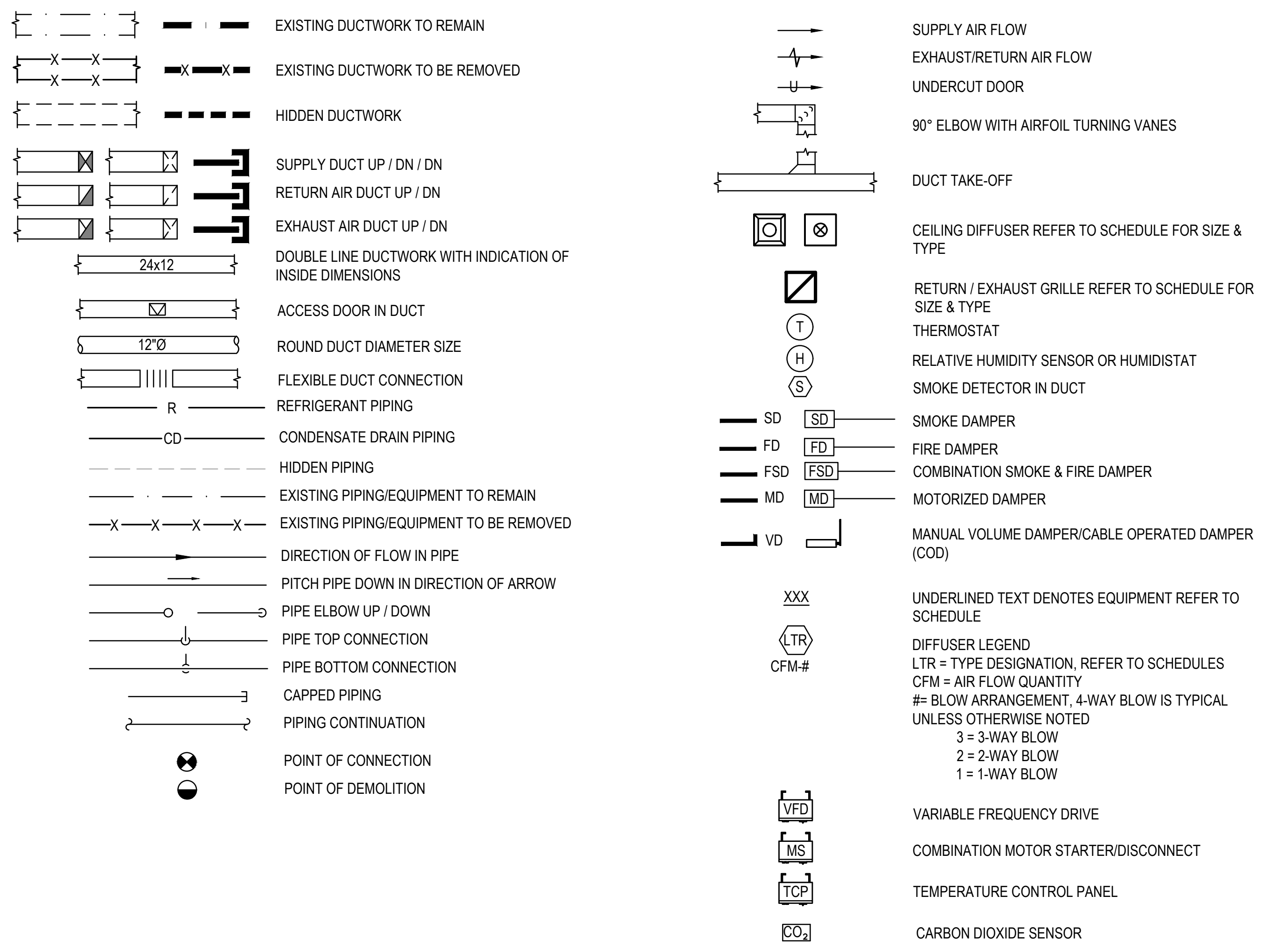
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Revision:	Description:	Date:	Revised By:

Drawing Title:
SCHEDULES AND DETAILS
State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: MPB
Project Number: 22.335
Drawing Number: P201

GENERAL MECHANICAL SYMBOLS



EXISTING DUCTWORK TO REMAIN
EXISTING DUCTWORK TO BE REMOVED
HIDDEN DUCTWORK
SUPPLY DUCT UP / DN / DN
RETURN AIR DUCT UP / DN
EXHAUST AIR DUCT UP / DN
DOUBLE LINE DUCTWORK WITH INDICATION OF INSIDE DIMENSIONS
ACCESS DOOR IN DUCT
ROUND DUCT DIAMETER SIZE
FLEXIBLE DUCT CONNECTION
REFRIGERANT PIPING
CONDENSATE DRAIN PIPING
HIDDEN PIPING
EXISTING PIPING/EQUIPMENT TO REMAIN
EXISTING PIPING/EQUIPMENT TO BE REMOVED
DIRECTION OF FLOW IN PIPE
PITCH PIPE DOWN IN DIRECTION OF ARROW
PIPE ELBOW UP / DOWN
PIPE TOP CONNECTION
PIPE BOTTOM CONNECTION
CAPPED PIPING
PIPING CONTINUATION
POINT OF CONNECTION
POINT OF DEMOLITION

SUPPLY AIR FLOW
EXHAUST/RETURN AIR FLOW
UNDERCUT DOOR
90° ELBOW WITH AIRFOIL TURNING VANES
DUCT TAKE-OFF
CEILING DIFFUSER REFER TO SCHEDULE FOR SIZE & TYPE
RETURN / EXHAUST GRILLE REFER TO SCHEDULE FOR SIZE & TYPE
THERMOSTAT
RELATIVE HUMIDITY SENSOR OR HUMIDISTAT
SMOKE DETECTOR IN DUCT
SMOKE DAMPER
FIRE DAMPER
COMBINATION SMOKE & FIRE DAMPER
MOTORIZED DAMPER
MANUAL VOLUME DAMPER/CABLE OPERATED DAMPER (COD)
UNDERLINED TEXT DENOTES EQUIPMENT REFER TO SCHEDULE
DIFFUSER LEGEND
LTR = TYPE DESIGNATION, REFER TO SCHEDULES
CFM = AIR FLOW QUANTITY
#= BLOW ARRANGEMENT, 4-WAY BLOW IS TYPICAL UNLESS OTHERWISE NOTED
3 = 3-WAY BLOW
2 = 2-WAY BLOW
1 = 1-WAY BLOW
VARIABLE FREQUENCY DRIVE
COMBINATION MOTOR STARTER/DISCONNECT
TEMPERATURE CONTROL PANEL
CARBON DIOXIDE SENSOR

* ALL SYMBOLS MAY NOT BE USED IN THESE DOCUMENTS.

GENERAL MECHANICAL ABBREVIATIONS

ABV	ABOVE	FA	FACE AREA	NTS	NOT TO SCALE
AC	AIR COMPRESSOR	FB	FLOW BAR	OA	OUTSIDE AIR
ACC-#	AIR COOLED CONDENSER	FC	FORWARD CURVE	OAT	OUTDOOR AIR TEMPERATURE
ACU-#	AIR CONDITIONING UNIT	F.C.	FLEX CONNECTION	OAI	OUTDOOR AIR INTAKE
ACCU-#	AIR COOLED CONDENSING UNIT	FC-#	FAN COIL	OBD	OPPOSED BLADE DAMPER
AD	ACCESS DOOR	FCU-#	FAN COIL UNIT	OD	OUTSIDE DIMENSION
AF	AIRFOIL	FD	FIRE DAMPER WITH ACCESS DOOR	O.E. T.D.	OPEN END TRANSFER DUCT
AFC	ADJUSTABLE FREQUENCY CONTROLLER	FF	FINAL FILTER	OED	OPEN END DUCT
AFF	ABOVE FINISHED FLOOR	FIN FL	FINISH FLOOR	P-#	PUMP
AFMS	AIR FLOW MEASURING STATION	FL	FLOOR	PB	PUSH BUTTON
AHU-#	AIR HANDLING UNIT	FLA	FULL LOAD AMPERES	PBD	PARALLEL BLADE DAMPER
AL	ACOUSTIC LINING	FLEX	FLEXIBLE	PD	PRESSURE DROP
ALD	AUTOMATIC LOUVER DAMPER	FO	FLAT OVAL	PF	PREFILTER
ALP	ACOUSTICALLY LINED PLENUM	FPF	FINS PER FOOT	PH	PHASE
APD	AIR PRESSURE DROP	FT	FEET	PHC	PREHEAT COIL
AUTO	AUTOMATIC	F.T.	FLOAT & THERMOSTATIC TRAP	PPH	POUND PER HOUR
B-#	BOILER	FT-#	FIN TUBE RADIATION	PRV	PRESSURE REDUCING VALVE
BC	BACKWARD CURVED	FV	FACE VELOCITY	PSI	POUND PER SQUARE INCH
BD	BYPASS DAMPER	GC	GENERAL CONTRACTOR	RA	RETURN AIR
BMCS	BUILDING MANAGEMENT & CONTROL SYSTEM	GIH	GRAVITY INTAKE HOOD	RAD	RETURN AIR DAMPER
BTU	BRITISH THERMAL UNIT	GPH	GALLONS PER HOUR	RAF-#	RETURN AIR FAN
BV	BYPASS VALVE	GPM	GALLONS PER MINUTE	RAT	RETURN AIR TEMPERATURE
CH-#	CHILLER	GT-#	GLYCOL TANK	REG	REGISTER
CHR	CHILLED WATER RETURN	H/C	HEATING/COOLING	RH	RELATIVE HUMIDITY
CHS	CHILLED WATER SUPPLY	H-#	HUMIDIFIER	RHC	REHEAT COIL
CAP	CAPACITY	H-O-A	HAND-OFF-AUTOMATIC	RLA	RATED LOAD AMPERES
CB-#	CONTROL BOX	HC-#	HEATING COIL	RM	ROOM
CC-#	COOLING COIL	HD	FEET OF HEAD	RP	RELIEF PENTHOUSE
CD	CEILING DIFFUSER	HP	HORSEPOWER	RPM	REVOLUTIONS PER MINUTE
CFM	CUBIC FEET PER MINUTE	HTG	HEATING	RTU-#	ROOFTOP AIR CONDITIONING UNIT
CG	CEILING GRILLE	HTR	HEATER	RV	RADIATION VALVE
CLG	CEILING	HV-#	HEATING AND VENTILATING UNIT	SA	SUPPLY AIR
C-#	CONVECTOR	HVAC	HEATING, VENTILATING &	SAF-#	SUPPLY AIR FAN
C.O.D.	CABLE OPERATED DAMPER		AIR CONDITIONING	SAT	SUPPLY AIR TEMPERATURE
CP	CONDENSATE RECEIVER/PUMPING SYSTEM	HX-#	HEAT EXCHANGER CONVERTOR	SB	SECURITY BARS
CR	CEILING REGISTER	IBT	INVERTED BUCKET TRAP	VSC	VERTICAL SPLIT CASE
CT-#	COOLING TOWER	ID	INSIDE DIMENSION	HSC	HORIZONTAL SPLIT CASE
CTD	CEILING TRANSFER DUCT	IN	INCHES	SD	SMOKE DAMPER
CUH-#	CABINET UNIT HEATER	IP	INTAKE PENTHOUSE	SG	SUPPLY GRILLE
CV	CONTROL VALVE	IV	INLET GUIDE VANES	SP	STATIC PRESSURE
D&T	DRIP AND TRAP	KW	KILOWATT	SQ FT	SQUARE FOOT (AREA)
DB	DRY BULB	KWH	KILOWATT HOUR	ST	SINGLE POLE SWITCH
DD	DIRECT DRIVE	IL	INLINE	TAB	TESTING, ADJUSTING, BALANCING
DDC	DIRECT DIGITAL CONTROL	LAT	LEAVING AIR TEMPERATURE	T'STAT	THERMOSTAT
DIFF	DIFFUSER	LD	LINEAR DIFFUSER	TB-#	TERMINAL BOX
DL	DOOR LOUVER	LIN	LINEAR	TCP	TEMPERATURE CONTROL PANEL
DN	DOWN	LRA	LOCKED ROTOR AMPERES	TD	TEMPERATURE DIFFERENCE
DP	DEWPOINT TEMPERATURE	LPR	LOW PRESSURE RETURN	TEMP	TEMPERATURE
DR	DROP	LPS	LOW PRESSURE SUPPLY	TG	AIR TRANSFER GRILLE
DX	DIRECT EXPANSION	LVG	LEAVING	TOT	TOTAL
EF-#	EXHAUST FAN	LWT	LEAVING WATER TEMPERATURE	TN-HR	TON HOUR REFRIGERATION
EAT	ENTERING AIR TEMPERATURE	MAN	MANUAL	TR	TOP REGISTER
EER	ENERGY EFFICIENCY RATIO	MAT	MIXED AIR TEMPERATURE	TRD	TRANSFER DUCT
EG	EXHAUST GRILLE	MAX	MAXIMUM	TT	THERMOSTATIC TRAP
EHC-#	ELECTRIC HEATING COIL	MBH	1000 BTU'S	TYP	TYPICAL
ENT	ENTERING	MCA	MINIMUM CIRCUIT AMPACITY	UC	UNDERCUT DOOR
HEPA	HIGH EFFICIENCY PARTICULATE FILTER	MD	MOTORIZED DAMPER	UH-#	UNIT HEATER HOT WATER
ER	EXHAUST REGISTER	MER	MECHANICAL EQUIPMENT ROOM	UV-#	UNIT VENTILATOR
ES	END SUCTION	MEZZ	MEZZANINE	VD	VOLUME DAMPER
ESP	EXTERNAL STATIC PRESSURE	MFS	MAXIMUM FUSE SIZE	VE	VOLUME EXTRACTOR
ET-#	EXPANSION TANK	MIN	MINIMUM	VFD	VARIABLE FREQUENCY DRIVE
ETR	EXISTING TO REMAIN	MTR	MOTOR	VI	VIBRATION ISOLATOR
EUH-#	ELECTRIC UNIT HEATER	MUA	MAKE-UP AIR	VSF	VARIABLE SPEED FAN SWITCH
EWT	ENTERING WATER TEMPERATURE	MV	MOTORIZED VALVE	W/	WITH
EXP-#	EXPANSION LOOP	NC	NOISE CRITERIA	WB	WET BULB
EX	EXISTING	NFA	NET FREE AREA	WFM	WATER FLOW MEASURING STATION
EXH	EXHAUST	NIC	NOT IN THIS CONTRACT	WMS	WIRE MESH SCREEN
EXT	EXTERNAL	NO	NORMALLY OPEN	WPD	WATER PRESSURE DROP
°F	DEGREES FAHRENHEIT			WT	WEIGHT (LBS)
F&B	FACE & BYPASS DAMPER			ZD	ZONE DAMPER

* ALL ABBREVIATIONS MAY NOT BE USED IN THESE DOCUMENTS.

MECHANICAL GENERAL NOTES

GENERAL

1. WHEN A CONFLICT BETWEEN THE DRAWINGS, NOTES AND/OR SPECIFICATIONS OCCUR, THE MORE STRINGENT, AND/OR LARGER QUANTITY AND/OR MORE EXPENSIVE SHALL APPLY. THE REQUIREMENTS LISTED WITHIN NOTES OR SPECIFICATIONS SHALL BE REQUIRED, PROVIDED AND INSTALLED WHETHER SPECIFICALLY INDICATED ON THE DRAWINGS OR NOT.
2. IT IS THE INTENTION OF THE SPECIFICATIONS AND DRAWINGS TO PROVIDE FOR FINISHED WORK, TESTED AND READY FOR OPERATION.
3. ITEMS AND SERVICES NOT SHOWN ON DRAWINGS OR SPECIFICATIONS BUT REQUIRED TO RENDER THE WORK COMPLETE AND READY FOR OPERATION, SHALL BE PROVIDED WITHOUT ADDITIONAL COST.
4. WORK OF THIS SECTION SHALL BE GOVERNED BY THE CONTRACT DOCUMENTS. PROVIDE MATERIALS, LABOR, EQUIPMENT AND SERVICES NECESSARY TO FURNISH, DELIVER AND INSTALL ALL WORK AS SPECIFIED AND AS REQUIRED BY JOB CONDITIONS. WHERE A CONFLICT EXISTS BETWEEN THESE NOTES, THE DRAWINGS AND THE SPECIFICATIONS, THE MORE STRINGENT REQUIREMENT SHALL APPLY.
5. DRAWINGS ARE DIAGRAMMATIC AND INDICATE A GENERAL ARRANGEMENT OF WORK AND ARE NOT TO BE CONSIDERED SUB-CONTRACTOR DOCUMENTS. IT IS THE INTENT OF THESE DOCUMENTS TO INCLUDE THE PROVISION AND INSTALLATION OF ALL NECESSARY WORK AND MATERIALS FOR COMPLETE, OPERATIONAL AND CODE COMPLIANT SYSTEMS BY THE CONTRACTOR. GENERAL DESIGN CONCEPTS INDICATED MUST BE FOLLOWED OR BETTERED. THE BID SHALL INCLUDE OFFSETS, ADDITIONAL PIPING, VALVES AND EQUIPMENT AND COMPONENTS AS REQUIRED TO MEET CONSTRUCTION CONDITIONS FOR PROPER OPERATION. DO NOT SCALE DRAWINGS. CONSULT ARCHITECTURAL AND STRUCTURAL DRAWINGS FOR SPACE CONDITIONS AND ADDITIONAL REQUIREMENTS.
6. PERFORM THE WORK IN ACCORDANCE WITH THE REQUIREMENTS OF THE CONTRACT GENERAL CONDITIONS AND WITH THE PROVISIONS OF ALL APPLICABLE LOCAL, STATE, AND FEDERAL CODES AND LAWS.
7. WORK SHALL INCLUDE ALL INCIDENTALS, LABOR, MATERIAL, EQUIPMENT, APPLIANCES, SERVICES, HOISTING, SCAFFOLDING, SUPPORTS, TOOLS, CONSUMABLE ITEMS, FEES, LICENSES, AND ADMINISTRATIVE TASKS REQUIRED TO COMPLETE AND MAKE OPERABLE WORK SHOWN ON THE DRAWINGS, SPECIFIED HEREIN AND AS REQUIRED FOR A COMPLETE AND OPERATIONAL SYSTEM.
8. STORE MATERIALS INSIDE AND PROTECTED FROM DEBRIS, WEATHER AND MOISTURE.
9. THIS CONTRACTOR SHALL PROVIDE AND INSTALL ALL POWER AND CONTROL WIRING REQUIRED FOR EQUIPMENT OPERATION NOT SPECIFICALLY PROVIDED BY OTHERS BUT REQUIRED FOR A COMPLETE AND OPERATIONAL SYSTEM. THIS CONTRACTOR SHALL PROVIDE MOTOR STARTERS. COORDINATE REQUIREMENTS WITH DIVISION 26.

ALTERATION WORK AND DEMOLITION

1. ALL EQUIPMENT, DUCTWORK, PIPING, CONTROL DEVICES, ETC. TO BE REMOVED, SHALL BE DISPOSED OF, TURNED OVER TO THE OWNER, OR SALVAGED AS DIRECTED BY THE OWNER. EQUIPMENT, DUCTWORK, PIPING, CONTROL DEVICES, ETC. SHALL NOT BE REMOVED FROM THE PREMISES WITHOUT THE OWNER'S APPROVAL.
2. UPON COMPLETION OF REMOVALS AND MODIFICATIONS, ALL DUCTWORK AND PIPING TO REMAIN SHALL BE PROPERLY VALVED, CAPPED AND/OR BY PASSED SUCH THAT UPON COMPLETION OF WORK ALL SYSTEMS TO REMAIN, REMAIN OPERATIONAL.
3. NO DEAD ENDS SHALL BE LEFT ON ANY DUCTWORK OR PIPING SYSTEM UPON COMPLETION OF WORK.
4. EXISTING DUCTWORK AND PIPING SYSTEMS NOT TO BE REUSED, AND NOT SPECIFICALLY NOTED FOR REMOVAL SHALL BE COMPLETELY REMOVED.
5. ALL SYSTEMS SHALL BE LEFT IN WORKING ORDER TO THE SATISFACTION OF THE OWNER UPON COMPLETION OF ALL NEW WORK.
6. ALL EXISTING UNNECESSARY DUCTWORK AND PIPING NOT RELATED TO NEW WORK SHALL BE COMPLETELY REMOVED.
7. RE-ROUTE ALL EXISTING DUCTWORK, PIPING AND SYSTEMS WHERE NECESSARY TO AVOID NEW EQUIPMENT, STRUCTURAL, OR MASONRY WORK AS REQUIRED BY THE PROPOSED ALTERATIONS.
8. WHERE PORTIONS OF EXISTING DUCT SYSTEMS ARE TO REMAIN CONTRACTOR TO TAKE AIRFLOW READINGS AT ALL AIR TERMINALS ASSOCIATED WITH THE DUCT SYSTEM TO BE MODIFIED BEFORE COMMENCEMENT OF WORK AND AFTER ALTERATION WORK IS COMPLETE. AIR BALANCING WORK SHALL BE PERFORMED BY AN INDEPENDENT NEEB CERTIFIED COMPANY, NOT ASSOCIATED WITH THE CONTRACTOR. REPORTS ARE TO BE ISSUED TO THE OWNER AND ENGINEER AT BOTH OCCURRENCES. IF AS-BUILTS ARE AVAILABLE, DISCREPANCIES NOTED BETWEEN THE AS BUILT DRAWINGS AND THE INITIAL AIR FLOW READINGS ARE TO BE NOTED ON THE AIR FLOW REPORT. EXISTING AIR TERMINALS ARE TO BE BALANCED TO THE ORIGINAL READINGS AT COMPLETION OF WORK UNLESS OTHERWISE IDENTIFIED.

SHOP DRAWINGS

1. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS TO BE REVIEWED BY THE ENGINEER PRIOR TO CONSTRUCTION. SHOP DRAWINGS SHALL BE SUBMITTED FOR DUCTWORK LAYOUT, PIPING LAYOUT, SHEET METAL SHOP STANDARDS AND ALL EQUIPMENT FURNISHED.
2. ELECTRONIC DRAWING FILES SHALL BE GENERATED BY THE CONTRACTOR. DRAWINGS SHALL BE SUBMITTED IN BOTH HARD COPY AND ELECTRONIC VERSION (AUTOCAD VERSION AS REQUIRED BY THE OWNER) OR AUTOCAD VERSION 2010 IF NOT SPECIFIED.
3. PRIOR TO THE SUBMISSION AND REVIEW OF SHEET METAL SHOP DRAWINGS, THE CONTRACTOR SHALL SUBMIT FOR REVIEW SHEET METAL SHOP STANDARDS. ANY SHEET METAL SHOP DRAWINGS SUBMITTED PRIOR TO THE SUBMISSION OF THE SHOP STANDARDS SHALL BE RETURNED "NOT REVIEWED".

COORDINATION DRAWINGS

1. ELECTRONIC DRAWING FILES SHALL BE GENERATED BY THE CONTRACTOR. IF REQUESTED, ELECTRONIC FILES OF THE MECHANICAL FLOOR PLANS, SECTIONS AND ELEVATIONS ONLY WILL BE MADE AVAILABLE. ELECTRONIC FILES WILL BE RELEASED ONLY UPON RECEIPT OF THE SIGNED AGREEMENT FOR TRANSFER OF ELECTRONIC FILE DATA, AGREEMENT FOR TRANSFER OF BUILDING INFORMATION MODEL AND ALL FEES INDICATED THEREIN.
2. DEVELOP AND SUBMIT COORDINATION DRAWINGS AS OUTLINED.
   A. SHEET METAL, PLUMBING AND FIRE PROTECTION SHOP DRAWINGS THAT HAVE BEEN COORDINATED WITH ARCHITECTURAL AND STRUCTURAL DRAWINGS SHALL BE SUBMITTED TO ENGINEER FOR REVIEW. DRAWINGS MUST BE RETURNED FROM ENGINEER EITHER "REVIEWED" OR "FURNISH AS CORRECTED" PRIOR TO BEING USED AS BASIS FOR COORDINATION DRAWINGS.
   B.AFTER SHEET METAL AND PIPING DRAWINGS HAVE BEEN REVISED PER ENGINEERS COMMENTS, REPRODUCIBLE COPIES SHALL BE SENT TO THE TRADES IN THE FOLLOWING SEQUENCE FOR THE INCLUSION OF THEIR WORK:

-MECHANICAL SHEET METAL
-PLUMBING PIPING
-MECHANICAL PIPING
-SPRINKLER PIPING
-ELECTRICAL WORK

2. AFTER ALL TRADES HAVE INCLUDED THEIR WORK ON THE COORDINATION DRAWING AND NOTED CONFLICTS, ALL TRADES SHALL MEET TO RESOLVE CONFLICTS AND AGREE TO ACCEPTABLE SOLUTIONS. EACH TRADE SHALL SIGN COORDINATION DRAWINGS. ITEMS NOT SHOWN ON COORDINATION DRAWING IS RESPONSIBILITY OF OMITTING CONTRACTOR AND CONTRACTOR IS SUBJECT TO ADDITIONAL COSTS INCURRED BY OTHER TRADES.
3. THE ARCHITECT AND ENGINEER ARE NOT PART OF THE COORDINATION DRAWING PROCESS. THE ENGINEER WILL PROVIDE ASSISTANCE FOR NOTED CONFLICTS ONLY. COORDINATION DRAWINGS ARE NOT TO BE CONSIDERED PIPING OR DUCT SHOP DRAWINGS. THE CONTRACTOR IS REQUIRED TO SUBMIT INDIVIDUAL PIPING AND DUCTWORK SHOP DRAWINGS FOR REVIEW BY THE ENGINEER. PIPING AND DUCTWORK SHOP DRAWINGS SHALL FOLLOW THE DESIGN INTENT OF THE CONTRACT DOCUMENTS.
4. SUBMIT FINAL SIGNED COORDINATION DRAWING TO ENGINEER FOR REVIEW. ENGINEER WILL REVIEW COORDINATION DRAWINGS FOR GENERAL ARRANGEMENT AND FOR NOTED CONFLICTS ONLY. SPECIFIC INSTALLATION REQUIREMENTS WILL BE REVIEWED ONLY IN INDIVIDUAL TRADE SHOP DRAWINGS.
5. ANY WORK FABRICATED OR INSTALLED PRIOR TO SIGN OFF BY ALL TRADES WHICH IS DEEMED TO BE IN CONFLICT WITH COORDINATION DRAWINGS SHALL BE REMOVED AND RE-INSTALLED IN CONFORMANCE WITH COORDINATION DRAWINGS.
6. EACH CONTRACTOR (MENTIONED ABOVE) IS RESPONSIBLE FOR THE COORDINATION OF HIS SUB-CONTRACTORS.
7. THE OVERALL COORDINATION OF THE COORDINATION PROCESS IS THE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER IS NOT RESPONSIBLE FOR THE COORDINATION PROCESS. THE ENGINEER WILL RESPOND TO QUESTIONS THAT ARISE FROM THE COORDINATION PROCESS. DRAWINGS SUBMITTED WILL BE REVIEWED FOR CLEARLY IDENTIFIED CONFLICTS ONLY. SOLUTIONS TO CONFLICTS WILL NOT BEAR ADDITIONAL COST.

AS BUILT DRAWINGS

1. PROVIDE A COMPLETE SET OF AS-BUILT DRAWINGS REFLECTING AS INSTALLED CONDITIONS. AS-BUILT DRAWINGS SHALL INDICATE ALL INSTALLED CONDITIONS OF SYSTEMS WITHIN THIS DISCIPLINE. DRAWINGS SHALL BE OF SIMILAR SCALE AS THE CONSTRUCTION DOCUMENTS AND INCLUDE DETAILS AS NECESSARY TO CLEARLY REFLECT THE INSTALLED CONDITION. DRAWINGS SHALL BE BOUND IN A COMPLETE AND CONSECUTIVE SET. SUPPLEMENTAL SKETCHES AND LOOSE PAPERWORK WILL NOT BE ACCEPTABLE AND WILL BE RETURNED FOR REVISION. THE CONTRACTOR SHALL COMPLY WITH THE ENGINEERS COMMENTS TO PRODUCE A CLEAR AND CONCISE SET OF DRAWINGS. DRAWINGS SHALL BE SUBMITTED IN BOTH HARD COPY AND ELECTRONIC VERSION (AUTO-CAD VERSION AS REQUIRED BY THE OWNER) OR AUTOCAD VERSION2010 IF NOT SPECIFIED. NUMBER OF COPIES OF EACH AS REQUESTED BY THE OWNER.
2. PROVIDE "AS-BUILT DRAWINGS" INDICATING IN A NEAT AND ACCURATE MANNER A COMPLETE RECORD OF ALL REVISIONS OF THE ORIGINAL DESIGN OF THE WORK. INDICATE THE FOLLOWING INSTALLED CONDITIONS:
3. INCLUDE ALL CHANGES AND AN ACCURATE RECORD IN AUTOCAD DRAWING OR APPROPRIATE SHOP DRAWINGS, OF ALL DEVIATIONS, BETWEEN THE WORK SHOWN AND WORK INSTALLED.
4. MAINS AND BRANCHES OF PIPING SYSTEMS, WITH VALVES AND CONTROL DEVICES LOCATED AND NUMBERED, CONCEALED UNIONS LOCATED, AND WITH ITEMS REQUIRING MAINTENANCE LOCATED (I.E., TRAPS, STRAINERS, EXPANSION COMPENSATORS, TANKS, ETC.). VALVE LOCATION DIAGRAMS, COMPLETE WITH VALVE TAG CHART.
5. EQUIPMENT LOCATIONS (EXPOSED AND CONCEALED), DIMENSIONED FROM PROMINENT BUILDING LINES.
6. APPROVED SUBSTITUTIONS, CONTRACT MODIFICATIONS, AND ACTUAL EQUIPMENT AND MATERIALS INSTALLED.
7. CONTRACT MODIFICATIONS, ACTUAL EQUIPMENT AND MATERIALS INSTALLED.
8. SUBMIT FOR REVIEW BOUND SETS OF THE REQUIRED DRAWINGS, MANUALS AND OPERATING INSTRUCTIONS.
9. SUBMIT A COMPLETE MAINTENANCE MANUAL OF ALL EQUIPMENT INSTALLED UNDER THIS CONTRACT.

HOUSEKEEPING PADS

1. PROVIDE CONCRETE HOUSEKEEPING PADS FOR FLOOR-MOUNTED EQUIPMENT. COORDINATE EXACT LOCATIONS, DIMENSIONS, PIPING LOCATIONS, AND ANCHOR BOLT REQUIREMENTS. PROVIDE CONCRETE HOUSEKEEPING PADS UNDER ALL FLOOR MOUNTED EQUIPMENT. PADS SHALL BE CONSTRUCTED OF 3,000 PSI CONCRETE. PADS SHALL BE 4 INCHES HIGH, AND MINIMUM 4 INCHES WIDER THAN THE EQUIPMENT IN BOTH DIRECTIONS.
2. COORDINATE FLOOR DRAIN LOCATIONS WITH RESPECT TO EQUIPMENT HOUSEKEEPING PADS. PLACE DRAINS SUCH THAT EDGE OF THE FLOOR GRATE EXTENDS NO CLOSER THAN 2 INCHES FROM THE SIDE OF THE PAD. FLOOR DRAINS TO BE COORDINATED WITH PLUMBING CONTRACTOR.

HANGERS AND SUPPORT

1. SEISMIC RESTRAINT: PROVIDE SEISMIC RESTRAINT AND EXPANSION OF ALL MECHANICAL EQUIPMENT AND SYSTEMS IN ACCORDANCE WITH STATE AND FEDERAL BUILDING CODE REQUIREMENTS. SUBMIT SHOP DRAWINGS SIGNED AND SEALED BY A LICENSED PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF THE PROJECT INDICATING ALL NECESSARY COMPONENT CUTS, PLAN LOCATIONS AND CALCULATIONS FOR A COMPLETE SYSTEM. IT IS THE RESPONSIBILITY OF THE HIRED ENGINEER TO ANALYSIS AND DETERMINE ALL THE QUANTITIES AND LOCATIONS OF ALL REQUIRED VIBRATION, & SEISMIC CONTROLS, DEVICES AND RESTRAINTS.
2. PROVIDE ALL NECESSARY STRUCTURAL MEMBERS INCLUDING ADDITIONAL STRUCTURAL SUPPORT TO SUPPORT PIPING AND EQUIPMENT. HANGERS AND SUPPORTS SHALL BE OF AN APPROVED DESIGN NECESSARY TO SUPPORT DUCTWORK, PIPING, EQUIPMENT AND TO KEEP IN PROPER ALIGNMENT AND PREVENT TRANSMISSION OF INJURIOUS THRUSTS AND VIBRATIONS. IN ALL CASES WHERE HANGERS, BRACKETS, ETC., ARE SUPPORTED FROM CONCRETE CONSTRUCTION, DO NOT WEAKEN CONCRETE OR PENETRATE WATERPROOFING. ALL HANGERS AND SUPPORTS SHALL BE CAPABLE OF SCREW ADJUSTMENT AFTER EQUIPMENT AND PIPING IS ERECTED. HANGERS SUPPORTING PIPING EXPANDING INTO LOOPS, BENDS AND OFFSETS SHALL BE SECURED TO THE BUILDING STRUCTURE IN SUCH A MANNER THAT HORIZONTAL ADJUSTMENT PERPENDICULAR TO THE RUN OF PIPING SUPPORTED MAY BE MADE TO ACCOMMODATE DISPLACEMENT DUE TO EXPANSION. ALL SUCH HANGERS SHALL BE FINALLY ADJUSTED BOTH IN THE VERTICAL AND HORIZONTAL DIRECTION, AS REQUIRED. HANGERS IN CONTACT WITH COPPER OR BRASS PIPE SHALL BE DIELECTRIC, COMPATIBLE WITH COPPER AND BRASS ALLOY OR PROVIDED WITH FELT SLEEVE.
3. PROVIDE ADDITIONAL SUPPORT FOR DUCTWORK PIPING AND EQUIPMENT WHEN DECK IS NOT CAPABLE OF SUPPORT.
4. BEAM CLAMPS - HANGERS SUPPORTED FROM STEEL SHALL BE CENTER LOADING BEAM CLAMPS FOR HANGERS SUPPORTING PIPING 2 INCHES. FOR PIPING 2-1/2 INCHES AND LARGER, I BEAM CLAMPS SHALL BE FORGED STEEL. "C" CLAMPS ARE NOT TO BE USED.
5. PROVIDE AND INSTALL EXPANSION COMPENSATION FOR ALL PIPING. SUBMIT PLANS, CALCULATIONS AND EQUIPMENT DATA.

MECHANICAL PHASING NOTES

1. THIS PROJECT CONSISTS OF MULTIPLE PHASES OF CONSTRUCTION OVER A SPECIFIED TIME PERIOD. PROVIDE ALL WORK NECESSARY TO KEEP EXISTING SYSTEMS IN SAFE OPERATION. PROVIDE ISOLATION (SHUTOFF) VALVES AT ALL CONNECTION POINTS TO EXISTING SYSTEMS.
2. CONTRACTOR TO COORDINATE WITH CONSTUCTION MANAGER. CONSTRUCTION MANAGER WILL BE DICTATING THE PHASING SCHEDULE OF THIS PROJECT.
3. WORK SHALL BE PHASED TO ALLOW OWNER TO CONTINUE BUSINESS OPERATIONS DURING THE CONSTRUCTION PERIOD. COORDINATE WORK WITH OWNER AND GENERAL CONTRACTOR TO ALLOW SUFFICIENT TIME TO RELOCATE OPERATIONS WIITHIN THE BUILDING PRIOR TO COMMENCING WORK IN AREAS AFFECTED BY DEMOLITION OR NEW CONSTRUCTION.
4. WORK REQUIRING INTERRUPTION OF ESSENTIAL BUILDING SERVICES SHALL BE PERFORMED DURING UNOCCUPIED PERIODS (AFTER BUSINESS HOURS), ESSENTIAL SERVICES SHALL INCLUDE BUT NOT BE LIMITED TO VENTILATION, WATER AND SEWER SERVICE, POWER, TELECOMMUNICATIONS. HEATING AND AIR CONDITIONING SHALL BE CONSIDERED TO BE ESSENTIAL WHEN CONDITIONS WILL CAUSE TEMPERATURES IN THE BUILDING TO FALL BELOW 68°F OR EXCEED 78°F.
5. CONTRACTOR TO PROVIDE TEMPORARY HEATING DURING PHASES OF CONSTRUCTION OCCURRING DURING COLDER SEASONS. CONTRACTOR TO PROVIDE ALL NECESSARY COMPONENTS AND DEVICES.
6. CONTRACTOR TO PERFORM THE TESTING AND BALANCING PROCEEDURE MULTIPLE TIMES AS NECESSARY FOR HVAC EQUIPMENT SERVING AREAS UNDER MORE THAN ONE PHASE.

MECHANICAL DEMOLITION NOTES

1. COORDINATE PHASING OF DEMOLITION WITH C.M./G.C. AND PROPOSED CONSTRUCTION SCHEDULE TO MAINTAIN MECHANICAL SERVICES (HEATING, TEMPERATURE CONTROLS, EXHAUSTS, MAKE UP AIR ETC.) TO OCCUPIED AREAS OF THE BUILDING DURING CONSTRUCTION.
2. THE EXISTING FACILITY WILL BE OCCUPIED AND IN OPERATION DURING THE PERFORMANCE OF THE WORK.
3. WHEN NECESSARY TO TEMPORARILY DISCONNECT ANY EXISTING PIPING OR DUCTWORK WHICH MAY CAUSE DISRUPTION TO OCCUPIED FACILITIES, CONFER WITH THE OWNER, AND SCHEDULE A MUTUALLY AGREEABLE PERIOD OF INTERRUPTION.
4. WHERE REPLACEMENT, RELOCATION OR MODIFICATION OF EXISTING EQUIPMENT IS INDICATED, PROVIDE AND MAINTAIN ALL TEMPORARY SERVICES, CONNECTIONS, CONTROLS, AND ANY OTHER MATERIALS AND APPURTENANCES REQUIRED TO MAINTAIN SERVICES TO OCCUPIED AREAS.
5. NO WORK SHALL BE LEFT INCOMPLETE, NOR ANY HAZARDOUS SITUATION CREATED, WHICH WILL AFFECT THE LIFE OR SAFETY OF THE PUBLIC AND/OR BUILDING OCCUPANTS. AT NO TIME SHALL THE WORK INTERFERE WITH OR CUT OFF ANY OF THE EXISTING SERVICES WITHOUT THE OWNER'S PRIOR WRITTEN PERMISSION.
6. THE OWNER RESERVES THE RIGHT TO OPERATE ALL EXISTING MECHANICAL EQUIPMENT UNTIL THE NEW SYSTEMS COME ON LINE.
7. IT IS REQUIRED THAT THE WORK INDICATED AND/OR SPECIFIED SHALL BE CARRIED OUT WITH A MINIMUM OF INTERFERENCE TO THE ESTABLISHED OPERATIONS OF THE BUILDING.
8. REMOVED MATERIALS SHALL BE DISPOSED OF USING LICENSED CARTING SERVICE.
9. HAZARDOUS MATERIALS SHALL BE DISPOSED OF BY AN EPA APPROVED, LICENSED DISPOSAL SERVICE. CONTRACTOR SHALL OBTAIN AND HAVE ON FILE, AFFIDAVIT, AND RECEIPTS STATING HOW AND WHERE THE WASTE WAS DISPOSED OF OR CONVERTED.
10. IT IS THE INTENTION OF THESE DEMO DRAWINGS TO INDICATE GENERAL SYSTEMS AND MATERIALS TO BE REMOVED. CONTRACTOR SHALL REMOVE ALL OBSOLETE PIPING, DUCTWORK, EQUIPMENT, CONTROLS, ETC, INDICATED OR NOT.
11. DUCTWORK, EQUIPMENT AND TERMINAL DEVICES HAVE BEEN TAKEN FROM FIELD OBSERVATION AND ARE TO BE USED FOR REFERENCE AND SHALL NOT BE CONSTRUED TO BE ACTUAL FIELD CONDITIONS. CONTRACTOR IS RESPONSIBLE TO VERIFY ALL SYSTEMS PRIOR TO COMMENCEMENT OF DEMOLITION WORK.
12. ALL EQUIPMENT TO BE REMOVED SHALL BE DISPOSED OF PER OR STORED PER DIRECTION OF OWNER. ANY ITEM NOT RETAINED BY OWNER SHALL BE REMOVED FROM SITE AND DISCARDED IN AN APPROVED MANNER.
13. IT IS THE INTENTION OF THESE SPECIFICATION TO REMOVE ALL MATERIALS ABANDONED BY THE SCOPE OF THIS CONSTRUCTION PROJECT. NO OBSOLETE MATERIALS (I.E. HANGERS, SUPPORTS, INSULATION, DUCTWORK, ETC.) SHALL REMAIN.
14. DISCONNECT AND REMOVE ALL DUCTWORK AND ASSOCIATED SUPPLY, RETURN OR EXHAUST GRILLES INCLUDING BUT NOT LIMITED TO ALL HANGERS, SUPPORTS, VOLUME DAMPERS AND FLEXIBLE DUCTWORK.
15. CONTRACTOR SHALL PROVIDE TEMPORARY PROTECTION TO ANY EXPOSED OR UNCAPPED NEW OR EXISTING DUCTWORK TO REMAIN TO MINIMIZE DUST CONTAMINATION IN ANY AND ALL OF THE AIR SYSTEMS. THIS SHALL INCLUDE BUT IS NOT LIMITED TO TEMPORARY FILTERS, CAPS, ENCLOSURES, ETC.

MECHANICAL GENERAL NOTES

1. COORDINATE ALL HVAC WORK AND EQUIPMENT WITH STRUCTURAL STEEL, FIRE PROTECTION PIPING, PLUMBING PIPING, LIGHT FIXTURES, ELECTRICAL EQUIPMENT AND OWNER'S EQUIPMENT.
2. ALL EXISTING CONDITIONS AS INDICATED ARE APPROXIMATIONS OF EXACT CONDITIONS TO BE VERIFIED IN THE FIELD. CONTRACTOR SHALL VISIT THE SITE TO VERIFY THE CONSTRUCTION CONDITIONS BEFORE SUBMITTING BID.
3. WHENEVER THE DOCUMENTS INDICATE FOR NEW PIPING TO CONNECT TO AN EXISTING PIPING SYSTEM (OTHER THAN A STEAM SYSTEM), CONTRACTOR SHALL INSTALL A TEMPORARY CORROSION INHIBITOR SYSTEM TO TREAT THE EXISTING PIPING. THE SYSTEM SHALL CONSIST OF AN INJECTOR , PIPING MODIFICATIONS AND APPLICABLE CHEMICALS REQUIRED TO TREAT THE EXISTING SYSTEM FOR A MINIMUM OF THREE WEEKS PRIOR TO ANY NEW CONNECTIONS. UPON INSTALLATION OF THE NEW PIPING SYSTEM, THE ENTIRE SYSTEM (NEW & EXISTING) SHALL BE FLUSHED WITH A CHEMICAL CLEANSING AGENT.
4. REFER TO ARCHITECTURAL REFLECTED CEILING PLANS FOR EXACT LOCATION OF ALL CEILING GRILLES, REGISTERS AND DIFFUSERS.
5. PROVIDE VOLUME DAMPERS IN EACH BRANCH DUCT SERVING DIFFUSER WHETHER INDICATED OR NOT.
6. PROVIDE CABLE OPERATED DAMPERS IN BRANCH DUCT SERVING DIFFUSERS IN INACCESSIBLE CEILING LOCATIONS WHETHER INDICATED OR NOT.
7. LOCATE ALL DUCT BALANCING DAMPERS ABOVE ACCESSIBLE CEILINGS, OR PROVIDE ACCESS DOORS.
8. PROVIDE TRAPPED CONDENSATION DRAIN PIPING FROM COOLING COIL DRAIN PAN TO DISCHARGE POINT INDICATED. (REFER TO PLUMBING PLANS FOR FLOOR DRAIN LOCATIONS).
9. RUN REFRIGERATION PIPING FROM AIR COOLED CONDENSING UNITS TO RESPECTIVE DX COOLING COILS. ROUTE AND SIZE PIPING PER EQUIPMENT MANUFACTURER'S RECOMMENDATIONS.
10. DUCTWORK INDICATED BY SINGLE LINE REPRESENTATION ARE GENERALLY SMALLER BRANCH ZONE DUCTS. COORDINATE ELEVATIONS AND PROVIDE NECESSARY OFFSETS.
11. WHEREVER EXISTING SYSTEMS ARE ALTERED OR EXTENDED THE INTEGRITY OF THE SYSTEM IS TO BE MAINTAINED AND FUNCTION FULLY AS BEFORE. COORDINATE SCHEDULE FOR HOOK-UPS TO EXISTING SYSTEMS AND EQUIPMENT REMOVAL OR RELOCATION WITH THE OWNER AND PERFORM THIS WORK AT SUCH TIMES TO ENSURE THAT PERIODS OF SHUTDOWN WILL BE ACCEPTABLE TO THE OWNER.
12. VERIFY EXACT LOCATION OF CONNECTION POINTS (NEW TO EXISTING) IN FIELD PRIOR TO CONSTRUCTION.
13. RELOCATE EXISTING DUCTWORK AND/OR PIPE WORK IN EXISTING CEILING SPACES TO ACCOMMODATE ALL RENOVATIONS AND ADDITIONS.
14. TAKE DOWN AND REINSTALL EXISTING CEILINGS IN ALL AREAS WHERE MECHANICAL WORK IS INDICATED AND EXISTING CEILINGS REMAIN. REFER TO ARCHITECTURAL REFLECTED CEILING PLAN DRAWINGS FOR LOCATIONS WHERE EXISTING CEILINGS REMAIN. REPLACE CEILING TILES DAMAGED DURING WORK.
15. PATCH ALL WALLS, FLOORS, CEILINGS, AND ROOFS TO MATCH EXISTING IN ALL CASES WHERE EXISTING WALLS, FLOORS, CEILINGS, AND ROOFS REMAIN AND HVAC DEMOLITION IS INDICATED.
16. THIS PROJECT CONSISTS OF MULTIPLE PHASES OF CONSTRUCTION OVER A SPECIFIED TIME PERIOD. PROVIDE ALL WORK NECESSARY TO KEEP EXISTING SYSTEMS IN SAFE OPERATION. PROVIDE ISOLATION (SHUTOFF) VALVES AT ALL CONNECTION POINTS TO EXISTING SYSTEMS.
17. PROVIDE FIRE DAMPERS, SMOKE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS AS REQUIRED TO MAINTAIN WALL & FLOOR RATINGS AS DEFINED IN ARCHITECTURAL DRAWINGS.
18. PROVIDE PITCH CORRECTION CURBS FOR ALL MECHANICAL EQUIPMENT AS REQUIRED. ROOF MOUNTED EQUIPMENT TO BE INSTALLED PLUMB AND LEVEL ACCORDING TO EQUIPMENT MANUFACTURERS INSTALLATION INSTRUCTIONS.
19. PROVIDE STAINLESS STEEL DRIP PANS WITH LEAK DETECTION FOR ALL SUSPENDED EQUIPMENT WITH COOLING COILS. LEAK DETECTION ALARM TO ALERT TO BUILDING MANAGEMENT SYSTEM (BMS).
20. ALL NEW MOTORIZED, BACKDRAFT, FIRE AND SMOKE DAMPERS SHALL BE SERVICEABLE. PROVIDE DUCT ACCESS DOORS FOR MAINTENANCE. CONTRACTOR TO COORDINATE WITH FACILITIES ENGINEER PRIOR TO INSTALLATION.
21. ALL 90° MITERED ELBOW SHALL BE EQUIPPED WITH TURNING VANES.
22. DUCT SMOKE DETECTORS SHALL BE INSTALLED BY DIVISION 23, PROVIDED BY DIVISION 28 AND WIRED BY DIVISIONS 26 & 28.
23. SIZES ASSOCIATED WITH ACOUSTICALLY LINED DUCTWORK REPRESENTS THE INTERNAL FREE AREA DIMENSION OF THE DUCTWORK REQUIRED. ALL DUCTWORK 15FT FROM EQUIPMENT INLETS & OUTLETS SHALL BE EQUIPPED WITH DUCT LINING.
24. REFER TO PLUMBING DRAWINGS FOR GAS PIPING, CONDENSATE PIPING AND CONNECTIONS TO EQUIPMENT.

MECHANICAL DRAWING LIST

DRAWING NUMBER	DRAWING DESCRIPTION
M001	NOTES, LEGENDS & ABBREVIATIONS - MECHANICAL
M010	BUILDING "B" FIRST & SECOND FLOOR DEMOLITION PLANS - MECHANICAL
M011	BUILDING "B" ROOF DEMOLITION PLAN - MECHANICAL
M110	BUILDING "B" FIRST & SECOND FLOOR PLANS - MECHANICAL
M111	BUILDING "B" ROOF PLAN - MECHANICAL
M201	DETAILS - MECHANICAL
M202	DETAILS - MECHANICAL
M301	SCHEDULES - MECHANICAL
M302	SCHEDULES - MECHANICAL
M303	SCHEDULES - MECHANICAL
M401	VRF SYSTEM DIAGRAMS - MECHANICAL
M402	VRF SYSTEM DIAGRAMS - MECHANICAL

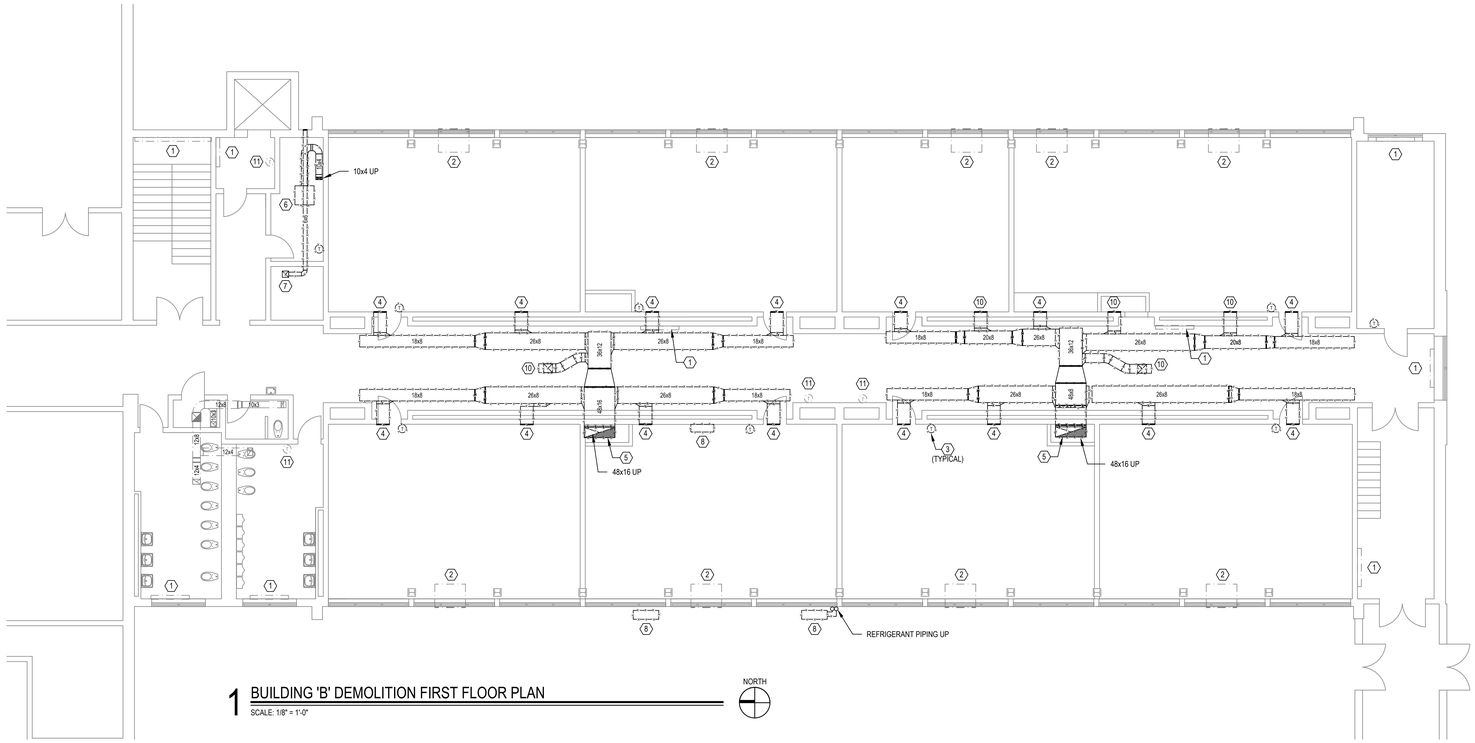
Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES
3190 WHITNEY AVENUE HAMDEN CT 06518
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203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

Drawing Title:
MECHANICAL NOTES, LEGENDS & ABBREVIATIONS
State Project #144-_ _ _ _ _ _

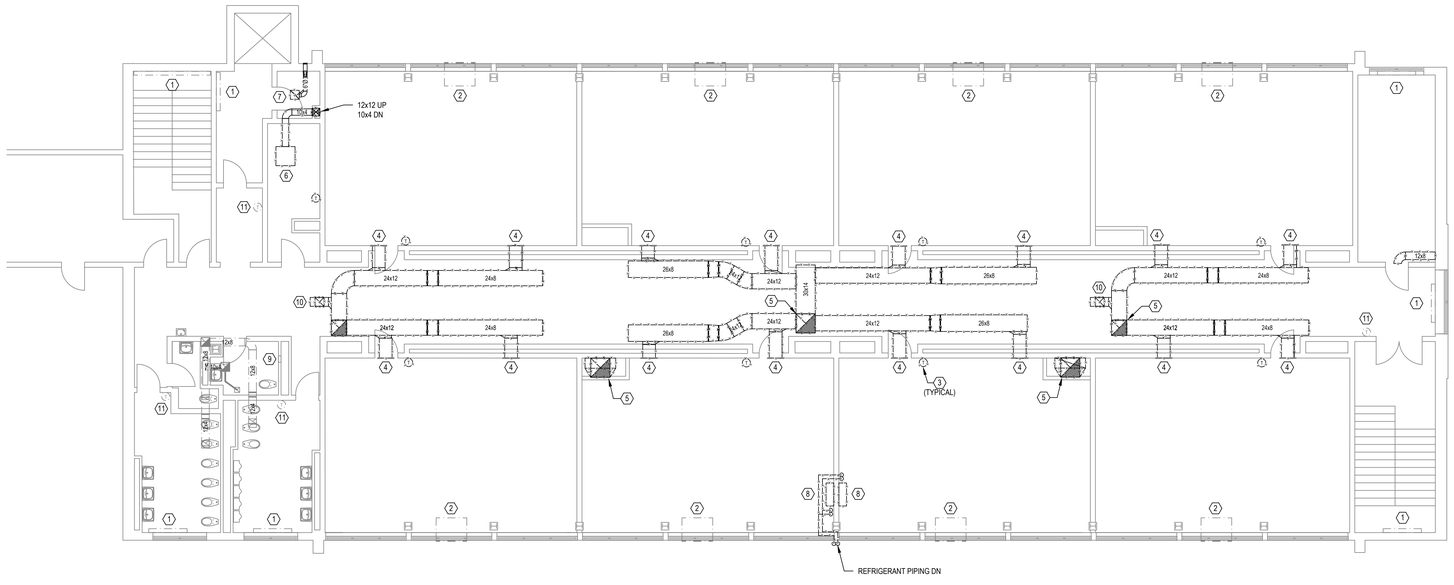
Date: 2-09-2024
Scale: AS NOTED
Drawn By: WJY
Project Number: 22.335
Drawing Number: M001



1 BUILDING 'B' DEMOLITION FIRST FLOOR PLAN

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

NORTH



2 BUILDING 'B' DEMOLITION SECOND FLOOR PLAN

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

NORTH

GENERAL NOTES

1. REFER TO DRAWING M001 FOR ADDITIONAL MECHANICAL NOTES.
2. CONTRACTOR TO PROVIDE ALL PENETRATIONS WITHIN WALLS, FLOORS, CEILINGS, ROOF, ETC. AS NECESSARY TO ACCOMMODATE NEW WORK.

MECHANICAL NOTES

1. EXISTING RADIATION AND ASSOCIATED CONTROLS TO REMAIN.
2. EXISTING UNIT VENTILATOR TO BE ABANDONED IN PLACE. ASSOCIATED CONTROLS TO BE REMOVED COMPLETELY. ASSOCIATED EXTERIOR LOUVER TO BE REMOVED AND REINSTALLED. CONTRACTOR TO PROVIDE SHEET METAL BLANK OFF PLATE BEHIND THE EXISTING LOUVER PRIOR TO REINSTALLING. EXISTING EXTERIOR WALL SHALL BE SEALED AIR/WATER TIGHT AND INSULATED.
3. EXISTING THERMOSTAT TO BE REMOVED.
4. EXISTING REGISTER/GRILLE TO REMAIN. ASSOCIATED DUCTWORK, FAN LOCATED ON ROOF, CONTROLS, ETC. SHALL BE REMOVED COMPLETELY.
5. EXISTING DUCT RISER UP TO ROOF FAN TO BE REMOVED.
6. EXISTING CABINET UNIT HEATER, ASSOCIATED DUCTWORK, ROOF INTAKE CAP, CONTROLS, ETC. TO BE REMOVED COMPLETELY.
7. EXISTING CEILING EXHAUST FAN, ASSOCIATED DUCTWORK, SUPPORTS, CONTROLS, EXHAUST LOUVER, ETC. TO BE REMOVED COMPLETELY.
8. EXISTING SPLIT SYSTEM INDOOR UNIT, ASSOCIATED OUTDOOR UNIT, CONTROLS, PIPING, ETC. TO BE REMOVED COMPLETELY. EXISTING INDOOR AND OUTDOOR UNIT SHALL BE TURNED OVER TO OWNER (TRUMBULL PUBLIC SCHOOL DEPT.).
9. EXISTING ELECTRIC CABINET UNIT HEATER TO REMAIN.
10. EXISTING GRILLE, ASSOCIATED DUCTWORK, FAN LOCATED ON ROOF, CONTROLS, ETC. SHALL BE REMOVED COMPLETELY.
11. EXISTING THERMOSTAT TO REMAIN.

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES

3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

Drawing Title:

BUILDING "B" FIRST & SECOND FLOOR DEMOLITION PLANS - MECHANICAL

State Project #144-_ _ _ _ _ _

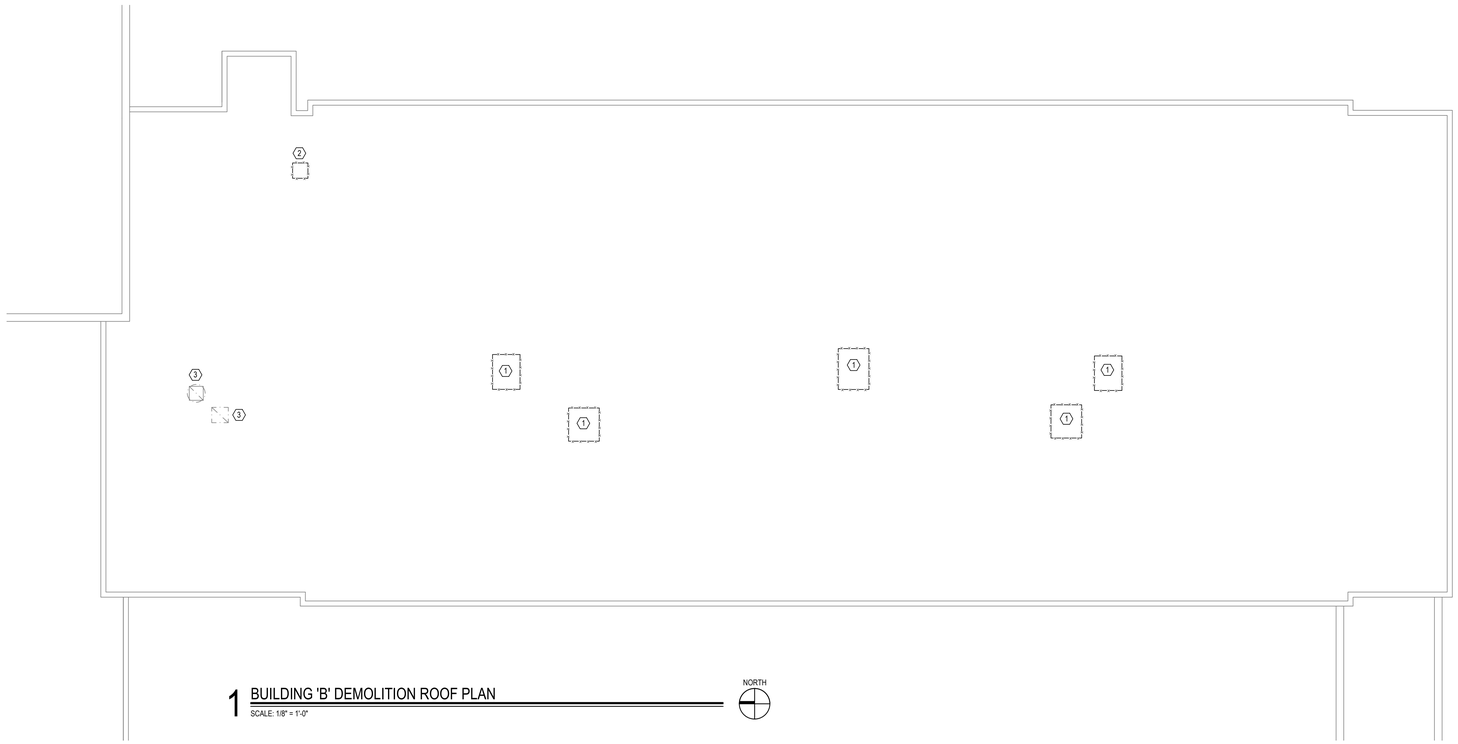
Date: 2-09-2024

Scale: AS NOTED

Drawn By: WJY

Project Number: 22.335

Drawing Number: M010



1 BUILDING 'B' DEMOLITION ROOF PLAN

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

NORTH

GENERAL NOTES

1. REFER TO DRAWING M001 FOR ADDITIONAL MECHANICAL NOTES.
2. CONTRACTOR TO PROVIDE ALL PENETRATIONS WITHIN WALLS, FLOORS, CEILINGS, ROOF, ETC. AS NECESSARY TO ACCOMMODATE NEW WORK.

MECHANICAL NOTES

(1) EXISTING FAN, ASSOCIATED DUCTWORK, CONTROLS, ETC. TO BE REMOVED COMPLETELY.

(2) EXISTING ROOF CAP AND ASSOCIATED ROOF CURB TO REMOVED.

(3) EXISTING FAN, ASSOCIATED DUCTWORK, CONTROLS, ETC. TO REMAIN.

Project Title:

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Revision:	Description:	Date:	Revised By:

Drawing Title:

BUILDING "B" ROOF DEMOLITION PLAN - MECHANICAL

State Project #144-_ _ _ _ _ _

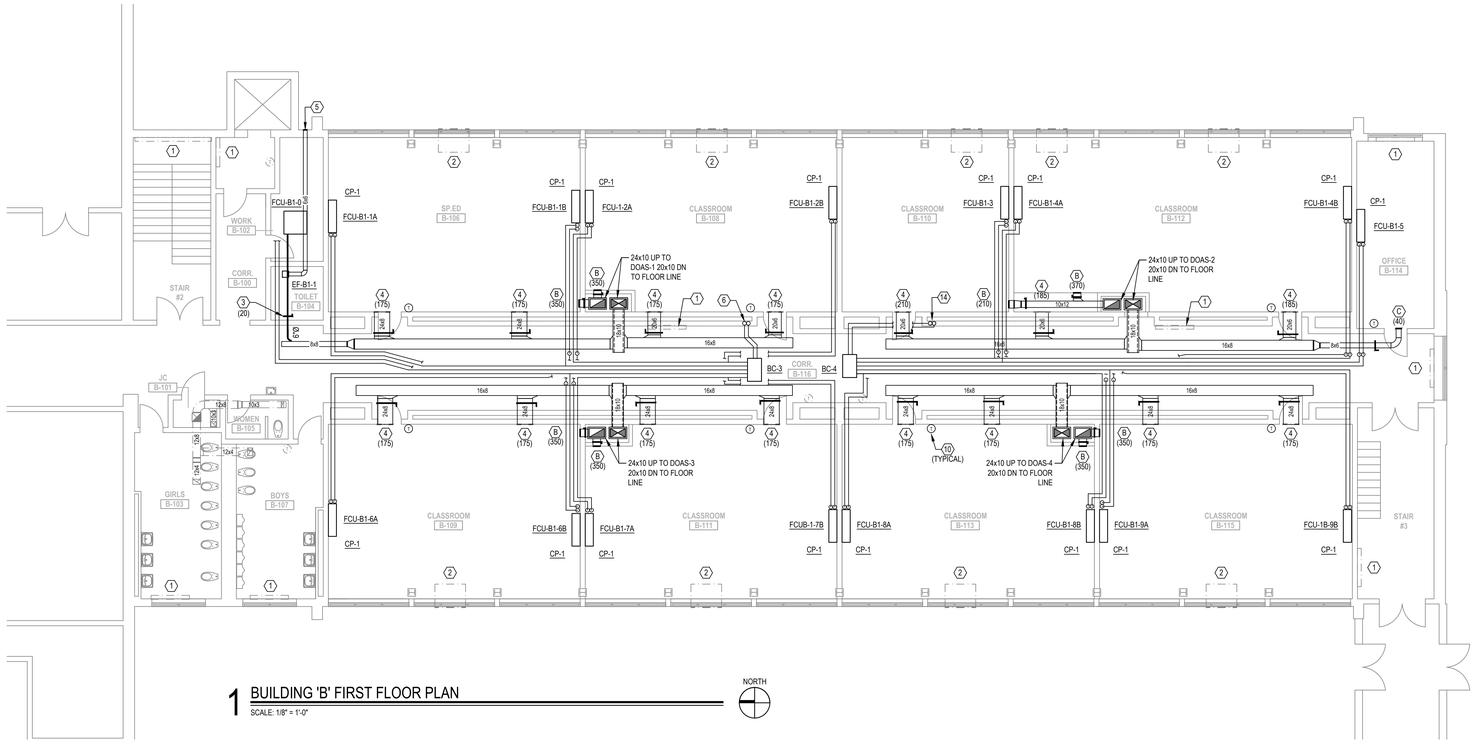
Date: 2-09-2024

Scale: AS NOTED

Drawn By: WJY

Project Number: 22.335

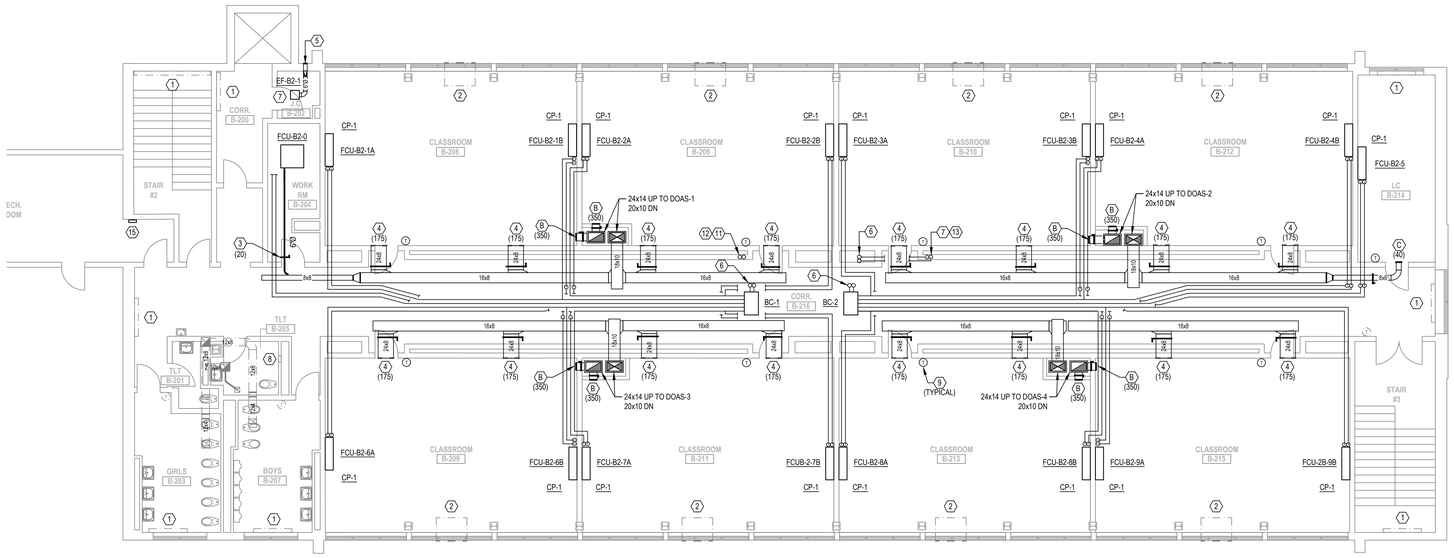
Drawing Number: M011



1 BUILDING 'B' FIRST FLOOR PLAN

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

NORTH



2 BUILDING 'B' SECOND FLOOR PLAN

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

NORTH

GENERAL NOTES

1. REFER TO DRAWING M001 FOR ADDITIONAL MECHANICAL NOTES.
2. UPON COMPLETION OF CONSTRUCTION, CONTRACTOR TO HIRE A CERTIFIED TESTING & BALANCING (TAB) CONTRACTOR TO BALANCE ALL NEW HVAC EQUIPMENT (DOAS-#, EF-#, FCU-#, HP-#, ETC.) AND ASSOCIATED DIFFUSERS/GRILLES TO AIR FLOWS (CFM) INDICATED ON DRAWINGS.
3. ALL NEW DUCTWORK & PIPING SHALL BE INSULATED AND LABELED. REFER TO SCHEDULES FOR INSULATION CHART. LABELS SHALL BE SETON CODE SELF-ADHESIVE DUCT MARKERS. LABELS SHALL BE LOCATED EVERY 20 FEET AND ON BOTH SIDES OF WALL PENETRATIONS.
4. CONTRACTOR TO PROVIDE ALL PENETRATIONS WITHIN WALLS, FLOORS, CEILINGS, ROOF, ETC. AS NECESSARY TO ACCOMMODATE NEW WORK.
5. SIZE AND ROUTE REFRIGERANT PIPING TO/FROM INDOOR UNITS (FCU-#) TO ASSOCIATED OUTDOOR UNIT (HP-#) PER MANUFACTURER'S REQUIREMENTS. CONTRACTOR IS RESPONSIBLE FOR QUANTITIES AND PURCHASING FAN COIL UNITS WITH THE REQUIRED LEFT OR RIGHT PIPING CONNECTIONS.
6. SIZES ASSOCIATED WITH ACOUSTICALLY LINED DUCTWORK REPRESENTS THE INTERNAL FREE AREA DIMENSION OF THE DUCTWORK REQUIRED.
7. CONTRACTOR SHALL PROVIDE ALL CONTROL DEVICES, RELAYS, SENSORS, PANELS, TRANSFORMERS, LOW VOLTAGE WIRING, PROGRAMMABLE CONTROLLERS, PROGRAMMING, ETC. NECESSARY TO ACHIEVE THE SEQUENCE OF OPERATION IN SPECIFICATION SECTION 230993 "SEQUENCE OF OPERATION FOR HVAC CONTROLS".

MECHANICAL NOTES

1. EXISTING RADIATION AND ASSOCIATED CONTROLS TO REMAIN.
2. EXISTING UNIT VENTILATOR TO BE ABANDONED IN PLACE. ASSOCIATED CONTROLS TO BE REMOVED COMPLETELY. ASSOCIATED EXTERIOR LOUVER TO BE REMOVED AND REINSTALLED. CONTRACTOR TO PROVIDE SHEET METAL BLANK OFF PLATE BEHIND THE EXISTING LOUVER PRIOR TO REINSTALLING. EXISTING EXTERIOR WALL SHALL BE SEALED AIR/WATER TIGHT AND INSULATED.
3. BALANCE VENTILATION AIR DAMPER TO AIR FLOW (CFM) INDICATED.
4. EXISTING REGISTER/GRILLE TO REMAIN SHALL BE CLEANED AND BALANCED TO THE AIR FLOW (CFM) INDICATED.
5. PROVIDE GREENHECK BRICK VENT TERMINATION MODEL EX.
6. REFRIGERANT PIPING UP TO ASSOCIATED OUTDOOR UNIT, HP-# LOCATED ON ROOF ABOVE.
7. REFRIGERANT PIPING DN.
8. EXISTING ELECTRIC CABINET UNIT HEATER TO REMAIN.
9. PROVIDE COMBINATION WALL MOUNTED DDC THERMOSTAT WITH CO2, HUMIDITY & OCCUPANCY FOR DOAS-#, FCU-#, ETC. ALL THERMOSTATS SHALL BE LABELED W/ASSOCIATED HVAC EQUIPMENT (DOAS-#, FCU-#, ETC.) PRIOR TO OCCUPANCY. (TYPICAL)
10. EXISTING THERMOSTAT TO REMAIN.
11. REFRIGERANT PIPING UP TO ASSOCIATED OUTDOOR UNIT, HP-# LOCATED ON ROOF AND DOWN TO BC CONTROLLER (BC-#) LOCATED ABOVE CEILING ON LEVEL BELOW.
12. CONTRACTOR TO USE LOCKER #254 AS A CHASE FOR REFRIGERANT PIPING ROUTING DOWN TO BC CONTROLLER, BC-#3. CONTRACTOR TO MODIFY EXISTING LOCKER AS NECESSARY TO ACCOMMODATE NEW WORK.
13. CONTRACTOR TO USE LOCKER #255 AS A CHASE FOR REFRIGERANT PIPING ROUTING DOWN TO BC CONTROLLER, BC-#4. CONTRACTOR TO MODIFY EXISTING LOCKER AS NECESSARY TO ACCOMMODATE NEW WORK.
14. REFRIGERANT PIPING UP.
15. PROVIDE BACNET MASTER CONTROLLER TE-200A. REFER TO SPECIFICATIONS AND VRF SYSTEM DIAGRAMS ON DRAWING M400.

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
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Trumbull, CT 06611

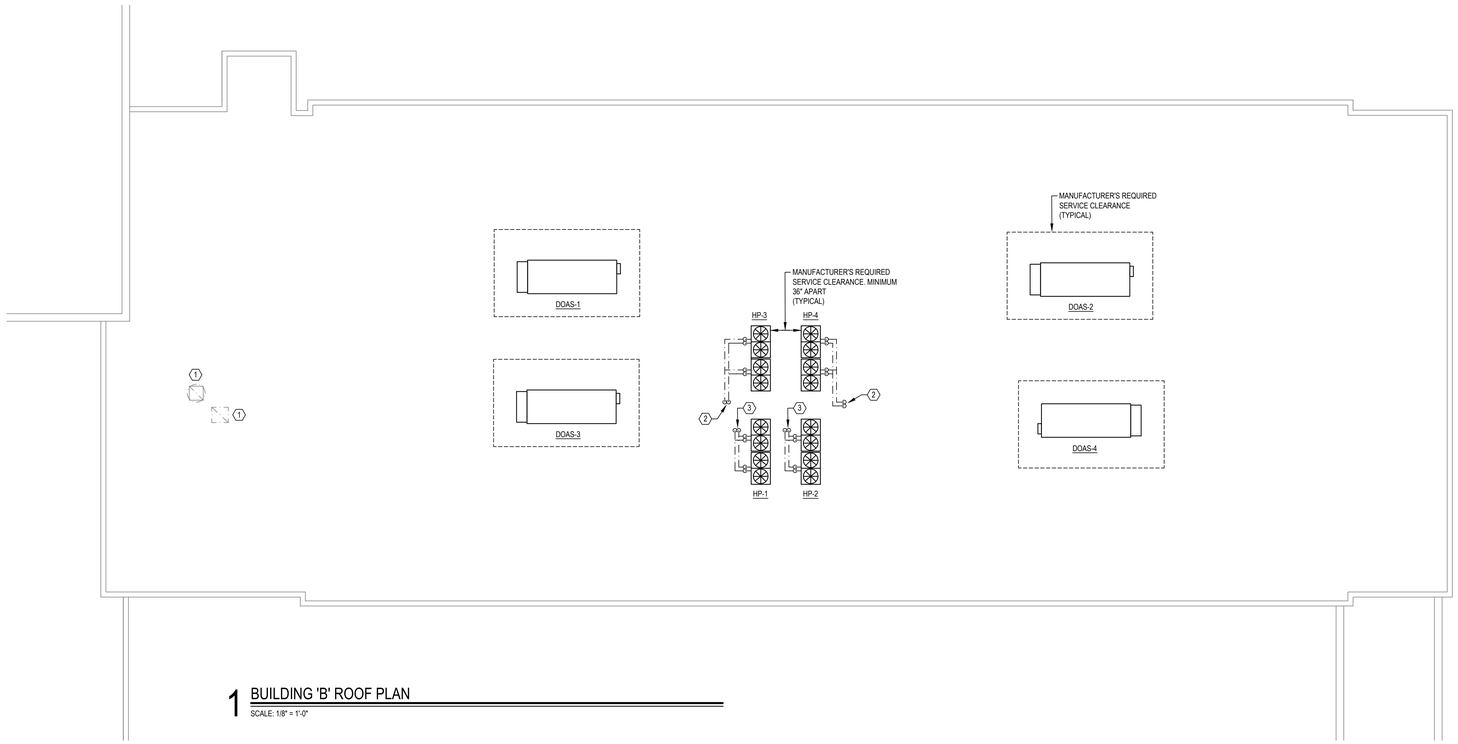
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Revision:	Description:	Date:	Revised By:

Drawing Title:
BUILDING "B" FIRST & SECOND FLOOR PLANS - MECHANICAL
State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: WJY
Project Number: 22.335

Drawing Number: M110



1 BUILDING 'B' ROOF PLAN

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

GENERAL NOTES

1. REFER TO DRAWING M001 FOR ADDITIONAL MECHANICAL NOTES.
2. CONTRACTOR TO PROVIDE ALL PENETRATIONS WITHIN WALLS, FLOORS, CEILINGS, ROOF, ETC. AS NECESSARY TO ACCOMMODATE NEW WORK.
3. ROOF TOP EQUIPMENT MUST BE A MINIMUM OF 11'-0" AWAY FROM EDGE OF THE ROOF.

MECHANICAL NOTES

1. EXISTING FAN, ASSOCIATED DUCTWORK, CONTROLS, ETC. TO REMAIN.
2. REFRIGERANT PIPING DN TO ASSOCIATED BC CONTROLLER, BC-# LOCATED ABOVE CORRIDOR CEILING ON LEVEL 1.
3. REFRIGERANT PIPING DN TO ASSOCIATED BC CONTROLLER, BC-# LOCATED ABOVE CORRIDOR CEILING ON LEVEL 2.

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Facilities HVAC Upgrade
220 Middlebrook Avenue
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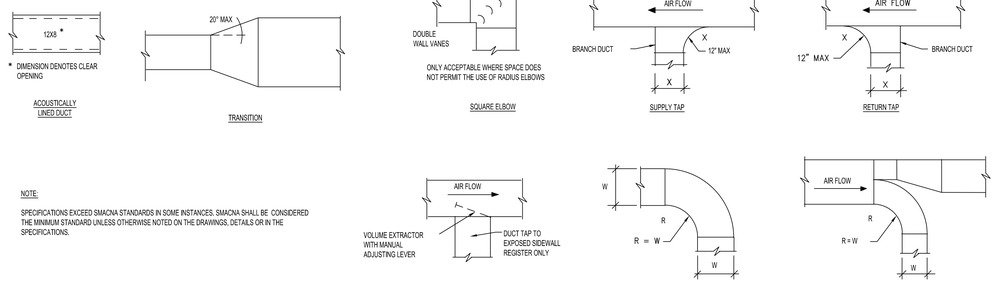
Revision:	Description:	Date:	Revised By:

Drawing Title:
BUILDING "B" ROOF PLAN - MECHANICAL

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: WJY
Project Number: 22.335

Drawing Number: M111

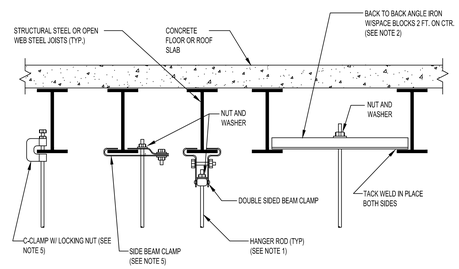


NOTE:

SPECIFICATIONS EXCEED SMACNA STANDARDS IN SOME INSTANCES. SMACNA SHALL BE CONSIDERED THE MINIMUM STANDARD UNLESS OTHERWISE NOTED ON THE DRAWINGS, DETAILS OR IN THE SPECIFICATIONS.

DUCT CONSTRUCTION DETAIL

NOT TO SCALE

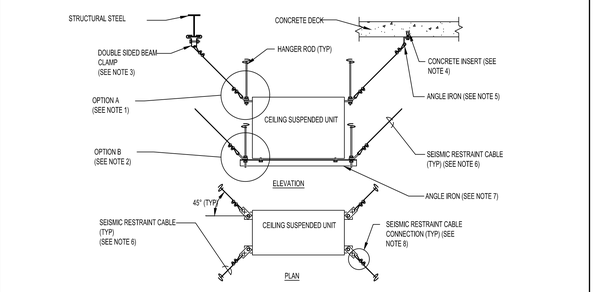


NOTES:

1. REFER TO SPECIFICATIONS FOR PIPE HANGER ROD SIZE. FOR CEILING SUSPENDED EQUIPMENT PROVIDE MIN. 3/8" DIA. HANGER ROD (REFER TO MANUFACTURER'S INSTALLATION INSTRUCTIONS).
2. FOR PIPES UNDER 2" USE A SINGLE 1-1/2"x1-1/2"x1/4" ANGLE IRON WITH C-CLAMP. FOR PIPES 2-1/2" AND LARGER USE 3"x3"x1/4" ANGLE IRON BACK TO BACK AS SHOWN.
3. REFER TO "TYPICAL METHOD OF SECURING HANGER RODS TO CONCRETE DECK DETAIL" FOR ATTACHING HANGER RODS TO CONCRETE DECK.
4. REPAIR OF FIREPROOFING IN ORDER TO FACILITATE THE INSTALLATION OF HANGER RODS IN EXISTING CONSTRUCTION SHALL BE BY THE G.C.
5. USE OF C-CLAMPS AND SIDE BEAM CLAMPS IS LIMITED TO PIPING 2-1/2" AND UNDER.

TYPICAL METHOD OF SECURING HANGER RODS TO STRUCTURAL STEEL DETAIL

NOT TO SCALE



NOTES:

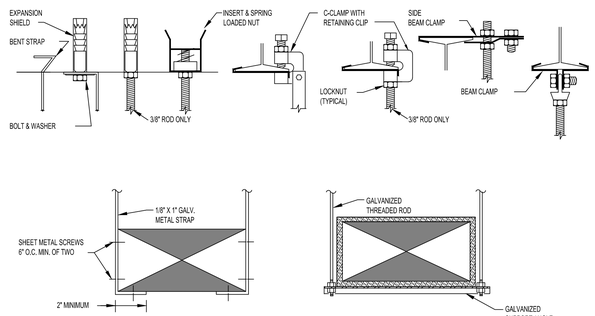
1. OPTION A APPLIES TO EQUIPMENT HAVING TOP OR SIDE ATTACHMENT.
2. OPTION B APPLIES TO EQUIPMENT SUPPORTED FROM THE BOTTOM OF THE EQUIPMENT.
3. USE DOUBLE SIDED BEAM CLAMPS FOR ATTACHMENT TO STRUCTURAL STEEL OR JOISTS.
4. USE CONCRETE INSERTS FOR ATTACHMENT TO CONCRETE DECK TYPE CONSTRUCTION.
5. ANGLE IRON SHALL BE 2-1/2"x5"x1/4" ANGLE 2" WIDE WITH (2) 9/16" HOLES FOR FASTENING TO CONCRETE DECK.
6. SIZE CABLE BASED ON SEISMIC HAZARD LEVEL SPECIFIED. PROVIDE CABLE WITH 1/2" OF SLACK WHERE CABLES ARE USED WITH VIBRATION ISOLATED EQUIPMENT.
7. PROVIDE (2) ANGLES FOR BOTTOM SUPPORT OF UNIT (OPTION B). PROVIDE (4) 2"x 2"x 2"x1/4" ANGLES WELDED TO BOTTOM SUPPORT ANGLES AND TO UNIT. (THIS IS NOT REQUIRED WHERE UNIT IS PROVIDED WITH BOTTOM MOUNTING HOLES).
8. REFER TO SMACNA "SEISMIC RESTRAINT MANUAL GUIDELINES FOR MECHANICAL SYSTEMS" FOR CABLE CONNECTION DETAIL.

TYPICAL SEISMIC BRACING FOR SUSPENDED EQUIPMENT DETAIL

NOT TO SCALE

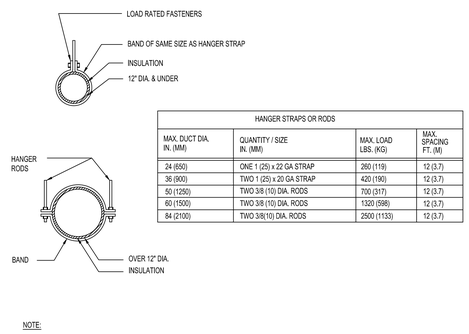
DUCT WIDTH	SUPPORT ANGLE OR EQUIV. CHANNEL	ROD DIA.	MAXIMUM SPACING	MAXIMUM AREA *
25" TO 30"	1 1/2" X 1 1/2" X 1/8"	3/8"	8'-0" O.C.	4 SQ. FT.
31" TO 42"	1 1/2" X 1 1/2" X 1/8"	3/8"	6'-0" O.C.	10 SQ. FT.
43" TO 60"	1 1/2" X 1 1/2" X 1/8"	1/2"	6'-0" O.C.	10 SQ. FT.
61" TO 84"	2" X 2" X 1/4"	1/2"	4'-0" O.C.	-
85" AND UP	2" X 2" X 1/4"	1/2"	4'-0" O.C.	-

* REDUCE SPACING TO NEXT SMALLER INTERVAL IF DUCT AREA EXCEEDS MAXIMUM



DUCT SUPPORT DETAIL

NOT TO SCALE



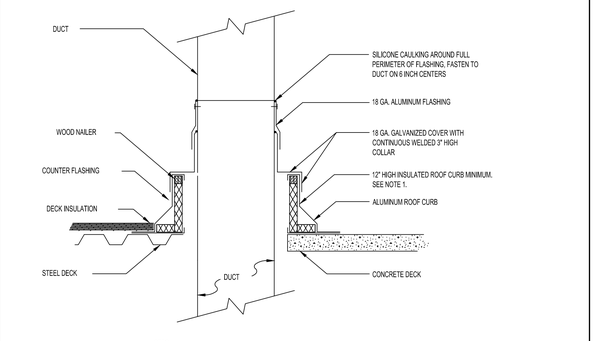
HANGER STRAPS OR RODS			
MAX. DUCT DIA. IN. (MM)	QUANTITY / SIZE IN. (MM)	MAX. LOAD LBS. (KG)	MAX. SPACING FT. (M)
24 (650)	ONE 1 (25) x 22 GA STRAP	260 (119)	12 (3,7)
36 (900)	TWO 1 (25) x 20 GA STRAP	420 (190)	12 (3,7)
50 (1250)	TWO 3/8 (10) DIA. RODS	700 (317)	12 (3,7)
60 (1500)	TWO 3/8 (10) DIA. RODS	1320 (598)	12 (3,7)
84 (2100)	TWO 3/8(10) DIA. RODS	2500 (1133)	12 (3,7)

NOTE:

1. TABULATED DATA FROM SMACNA ALLOWS FOR DUCT REINFORCING AND INSULATION, BUT NO EXTERNAL LOAD.

ROUND DUCTWORK HANGER DETAIL

NOT TO SCALE

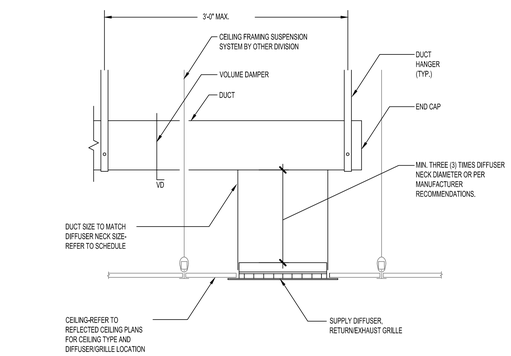


NOTES:

1. COORDINATE CURB STEP HEIGHT WITH ROOF DECK INSULATION THICKNESS

DUCT PENETRATION THROUGH ROOF DETAIL

NOT TO SCALE

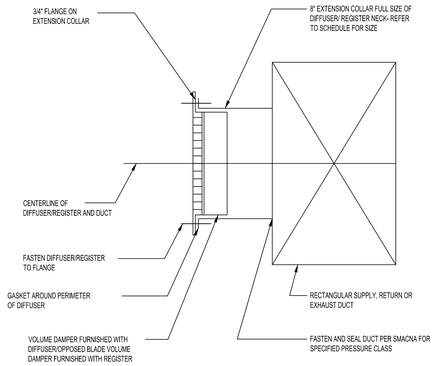


NOTE:

1. PROVIDE DIFFUSER W/OPPOSED BLADE CABLE OPERATED DAMPERS W/IN-AIRSTREAM OPERATORS WHERE INSTALLED IN HARD INACCESSIBLE CEILING.

TYPICAL SUPPLY, RETURN, EXHAUST OUTLET DETAIL

NOT TO SCALE

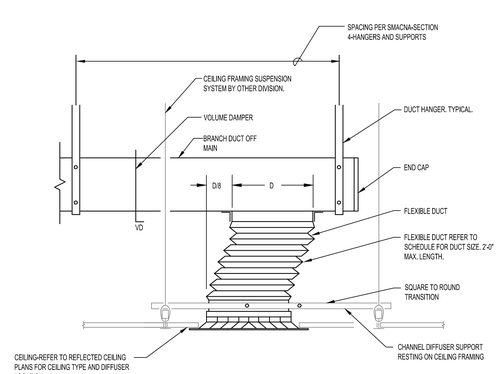


NOTES:

1. INSTALL DIFFUSER/REGISTER PER SMACNA AND MANUFACTURERS RECOMMENDATIONS.
2. ADJUST DIFFUSER VANES TO ANGLE INDICATED ON SCHEDULE AND MANUFACTURERS RECOMMENDATIONS.

TYPICAL RECTANGULAR EXPOSED DUCT SUPPLY, RETURN/EXHAUST REGISTER

NOT TO SCALE

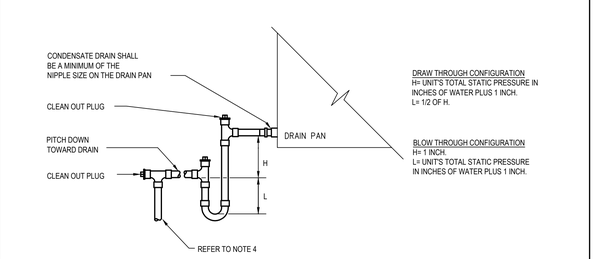


NOTES:

1. PROVIDE DIFFUSER W/OPPOSED BLADE CABLE OPERATED DAMPERS W/IN-AIRSTREAM OPERATORS WHERE INSTALLED IN HARD INACCESSIBLE CEILING.
2. OFFSET SHALL NOT EXCEED D/8".

TYPICAL SUPPLY DIFFUSER DETAIL WITH FLEXIBLE DUCTWORK CONNECTION

NOT TO SCALE



NOTES:

1. REFER TO MECHANICAL FLOOR PLANS AND SCHEDULES TO DETERMINE UNIT'S CONFIGURATION.
2. REFER TO MECHANICAL SCHEDULES FOR UNIT'S TOTAL STATIC PRESSURES.
3. MANUALLY PRIME TRAP PRIOR TO START-UP OF UNIT.
4. UNITS ABOVE CEILINGS: DRAIN PIPING SHALL BE INSULATED AND PIPED TO THE DISCHARGE POINT INDICATED WITH AN AIR GAP OF (2) TIMES THE CONDENSATE DRAIN SIZE.
5. UNITS ON ROOFS: DRAIN PIPING SHALL BE PIPED TO ROOF DRAIN, SPLASH BLOCK (BY THIS DIVISION) OR LOCATED INSIDE BUILDING.
6. UNITS INSIDE BUILDING: DRAIN PIPING SHALL BE INSULATED AND PIPED TO THE DISCHARGE POINT INDICATED WITH AN AIR GAP OF (2) TIMES THE CONDENSATE DRAIN SIZE.

COOLING COIL DRAIN TRAP DETAIL

NOT TO SCALE

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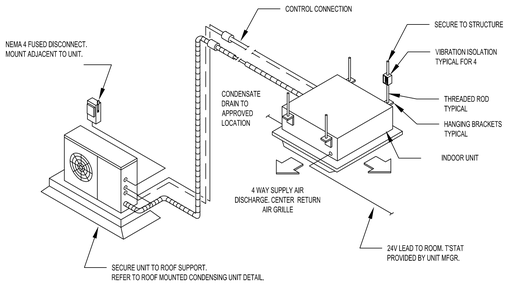
Drawing Title:

BUILDING "B"
MECHANICAL DETAILS

State Project #144-_ _ _ _ _ _

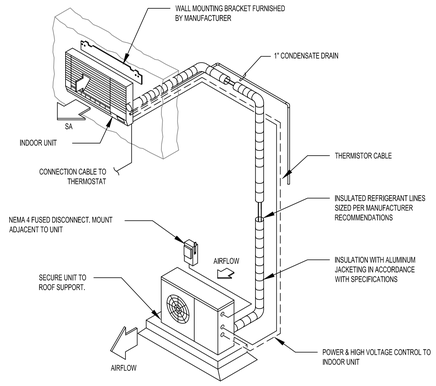
Date: 2-09-2024
Scale: AS NOTED
Drawn By: WJY
Project Number: 22.335

Drawing Number: M201



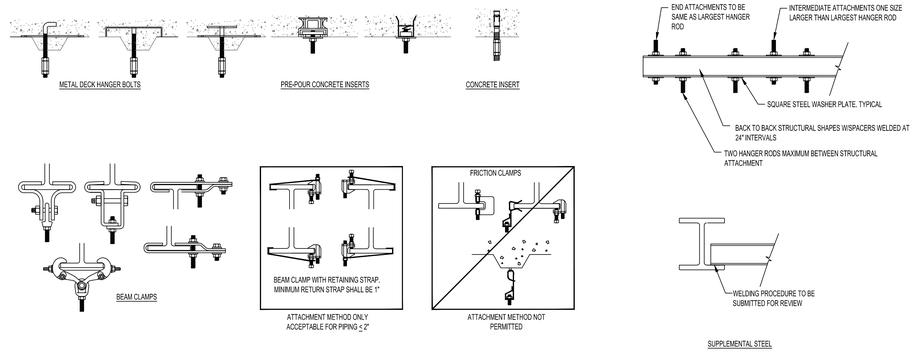
DUCTLESS AIR HANDLING UNIT, ROOF MOUNTED HEAT PUMP UNIT DETAIL

NOT TO SCALE



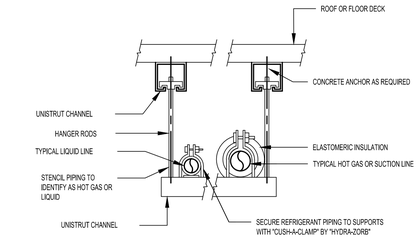
DUCTLESS AIR CONDITIONER, ROOF MOUNTED CONDENSING UNIT DETAIL

NOT TO SCALE

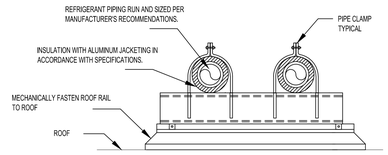


PIPE HANGER ATTACHMENT DETAIL

NOT TO SCALE

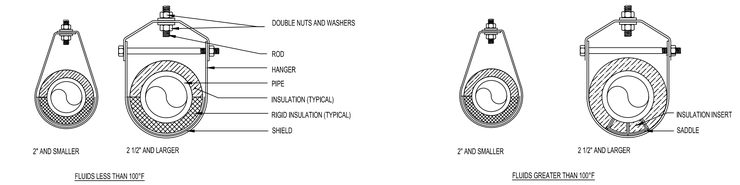


REFRIGERANT PIPE SUPPORT DETAIL



REFRIGERANT PIPING ROOF SUPPORT DETAIL

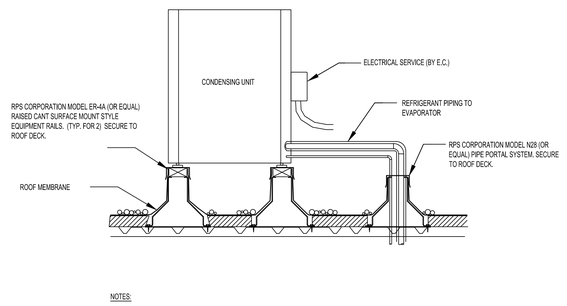
NOT TO SCALE



HANGER SCHEDULE		
PIPE SIZE	ROD SIZE	MAX. SPACING
UP TO 1 1/4"	3/8" DIA.	8' STEEL
UP TO 1 1/4"	3/8" DIA.	6' COPPER & BRASS
1 1/2" & 2"	3/8" DIA.	10'
2 1/2" & 3"	1/2" DIA.	10'
4" & 5"	5/8" DIA.	10'
6"	3/4" DIA.	10'
8", 10", 12"	7/8" DIA.	10'
14" & 16"	1" DIA.	10'
18"	1 1/8" DIA.	10'
20" & 24"	1 1/4" DIA.	10'

PIPE HANGER DETAIL

NOT TO SCALE

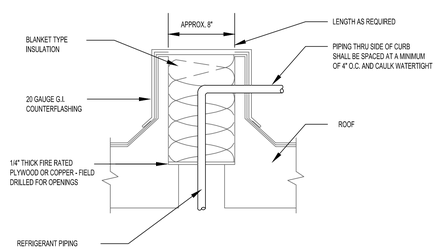


NOTES:

1. SECURE CONDENSING UNIT TO EQUIPMENT SUPPORT NAILER W/(4) 1/4" LAG BOLTS. SEAL ALL PENETRATIONS WATER TIGHT.
2. ALL REFRIGERANT PIPING ROOF PENETRATIONS SHALL BE MADE WEATHER-TIGHT.

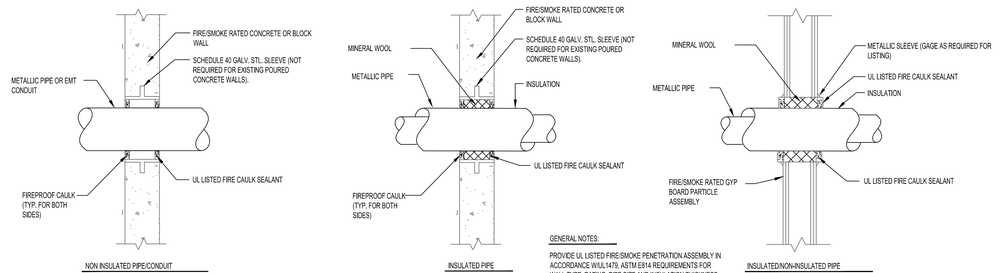
ROOF MOUNTED CONDENSING UNIT

NOT TO SCALE



ROOF CURB FOR REFRIGERANT PIPING THROUGH ROOF

NOT TO SCALE



PIPE PENETRATION WITH FIRE/SMOKE SEAL

NOT TO SCALE

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES

3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

Drawing Title:

BUILDING "B"
MECHANICAL DETAILS

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: WJY
Project Number: 22.335

Drawing Number: M202

DEDICATED OUTSIDE AIR SYSTEM SCHEDULE

MARK	AREA SERVED	MANUFACTURER /MODEL	SUPPLY AIR FANS					EXHAUST AIR FAN					ELECTRICAL			DX COOLING COIL										HOT GAS REHEAT	GAS HEATING SECTION						ENERGY RECOVERY HEAT EXCHANGER														FILTERS		OPER WT (LBS)	REMARKS
			NOMINAL CFM	SP (IN WG)		QNTY	HP EACH	NOMINAL CFM	SP (IN WG)		QNTY	HP EACH	Volts/Phs/Hz	MCA	MOCP	CAPACITY (NET)		EAT DB/WB (°F)	LAT DB/WB (°F)	MAX APD (IN.WG.)	MIN EER	MRC LB/HR	MRE LB/kWh	ROWS / FINS	LAT (°F) DB/WB	CAPACITY (MBH)	INPUT (MBH)	EAT (°F)	LAT (°F)	TURN DOWN RATIO	EFF %	TYPE	TYPE	OA CFM	EXH CFM	MOTOR HP	MAX APD (IN.WG.)	SUMMER OA		SUMMER EXH		WINTER OA		WINTER EXH		FILTERS			
				TSP	ESP				TSP	ESP						TOTAL MBH	SENS MBH																					EAT °F DB/WB	LAT °F DB/WB	EAT °F DB/WB	LAT °F DB/WB	EAT °F DB/WB	LAT °F DB/WB	EAT °F DB/WB	LAT °F DB/WB	TYPE	MID LIFE APD (IN.WG.)		
DOAS-1	REFER TO PLAN	TRANE / OABD108A4	1530	3.62	2.00	1	3	1585	2.12	1.00	1	1	460 / 3 / 60	24.7	35	86.2	53.4	80.6 / 67.2	47.1 / 47.0	0.13	14.4	43.54	4.97	4 12	70.0 / 56.83	80	100	49.2	97.4	5:1	80	NATURAL GAS	POLYMER WHEEL	1530	1430	0.17	1.0	95 / 74	80.6 / 67.2	75 / 64	90.5 / 71.9	0 / 0	49.2 / 44.6	70 / 58	18.0 / 17.8	MERV-13	-	2241	SEE BELOW
DOAS-2	REFER TO PLAN	TRANE / OABD084A4	1360	3.38	2.00	1	1.5	1360	2.08	1.00	1	1	460 / 3 / 60	21.5	30	73.2	45.1	79.7 / 66.7	47.9 / 47.4	0.10	15.2	38.62	5.31	4 12	70.0 / 56.86	80	100	52.3	106.5	5:1	80	NATURAL GAS	POLYMER WHEEL	1360	1360	0.17	1.0	95 / 74	79.7 / 66.7	75 / 64	90.3 / 71.8	0 / 0	52.3 / 46.8	70 / 58	18.5 / 18.4	MERV-13	-	2197	SEE BELOW
DOAS-3	REFER TO PLAN	TRANE / OABD096A4	1400	3.45	2.00	1	1.5	1400	2.10	1.00	1	1	460 / 3 / 60	23.3	35	79.8	49.0	79.8 / 66.8	46.2 / 46.1	0.11	14.3	41.27	5.00	4 12	70.0 / 56.44	80	100	51.9	104.6	5:1	80	NATURAL GAS	POLYMER WHEEL	1400	1400	0.17	1.0	95 / 74	79.8 / 66.8	75 / 64	90.2 / 71.8	0 / 0	51.9 / 46.6	70 / 58	18.8 / 18.7	MERV-13	-	2197	SEE BELOW
DOAS-4	REFER TO PLAN	TRANE / OABD096A4	1480	3.55	2.00	1	1.5	1480	2.15	1.00	1	1	460 / 3 / 60	23.3	35	81.2	50.3	80.0 / 66.9	47.4 / 47.2	0.12	14.4	41.92	4.99	4 12	70.0 / 56.88	80	100	51.2	101.0	5:1	80	NATURAL GAS	POLYMER WHEEL	1480	1480	0.17	1.0	95 / 74	80.0 / 66.9	75 / 64	90.0 / 71.7	0 / 0	51.2 / 46.1	70 / 58	19.5 / 19.4	MERV-13	-	2197	SEE BELOW

REMARKS:

1. UNIT SHALL UTILIZE R-410A REFRIGERANT. R-22 REFRIGERANT IS NOT ACCEPTABLE.
2. PROVIDE COMPLETE SET OF SPARE FILTERS (TOTAL NUMBER OF FILTER SETS = 2) FOR EACH UNIT.
3. ALL UNITS SHALL HAVE ENERGY WHEELS FOR RECOVERY OF ENERGY FROM EXHAUST AIR STREAM.
4. FURNISH UNITS WITH 100% RECIRCULATION DAMPER FOR UNOCCUPIED HEATING MODE.
5. FURNISH UNITS WITH SINGLE POINT POWER CONNECTION.
6. PROVIDE 120V SERVICE OUTLET.
7. PROVIDE FACTORY MOUNTED VARIABLE FREQUENCY DRIVE AND DISCONNECT SWITCH FOR SUPPLY FAN AND EXHAUST FAN.
8. PROVIDE DIRECT DRIVE MOTORS.
9. ALL FAN MOTOR DRIVE ASSEMBLIES SHALL BE MOUNTED ON 1.5 INCH STATIC DEFLECTION VIBRATION ISOLATORS.
10. PROVIDE 26" HIGH THYBAR CORPORATION ACOUSTICAL SEISMIC ROOF CURBS WITH MANSON INSULATION (2" ALLEY KAT AIR DUCT BOARD). PROVIDE PLENUM CURB WITH DIVIDER(S) TO MATCH ROOF PENETRATIONS AND ACCOMMODATE AIR PATHWAYS TO INLET AND OUTLET OF UNIT.
11. PROVIDE STAINLESS STEEL HEAT EXCHANGERS AND DRAIN PANS.
12. PROVIDE MODULATING HEATING AND HOT GAS REHEAT.
13. ALL UNITS SHALL BE EQUIPPED WITH MULTIPLE COMPRESSORS (VARIABLE SPEED COMPRESSORS).
14. PROVIDE POWERED EXHAUST WITH DIRECT DRIVE.
15. PROVIDE FACTORY INSTALLED OUTSIDE AIR FLOW STATION.
16. EQUIPMENT MUST BE PURCHASED FROM A COMMERCIAL SALES OFFICE THAT OFFERS FULL SALES, TECHNICAL SUPPORT AND HAS FULL SERVICE OPERATION WITH A MINIMUM OF (10) SERVICE TRUCKS. THE COMMERCIAL SALES OFFICE SHALL HAVE ACCESS TO ELECTRONIC SALES, SERVICE AND TECHNICAL SOFTWARE FOR COMPLETE SUBMITTAL PACKAGES AND AFTER-MARKET SUPPORT.
17. PROVIDE CONTROL AND MONITORING CAPABILITY THROUGH A BUILDING MANAGEMENT CONTROL SYSTEM.
18. PROVIDE FACTORY MOUNTED BACNET DDC UNIT CONTROLLER.
19. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION AND REQUIREMENTS.

FAN SCHEDULE

MARK	LOCATION	SYSTEM SERVED	TYPE	CFM	ESP	MAX BHP	FAN RPM	TIP SPEED	SOUND SONES	ELECTRICAL DATA				MAKE/ MODEL	OPER WEIGHT (LB)	REMARKS
										HP	VOLTS	Ø	RPM			
EF-B1-1	TOILET RM B-104	TOILET RM B-104	CEILING MOUNT	75	0.25	-	879	-	0.6	6W	115	1	1725	GREENHECK / SP-80-VG	16	SEE BELOW
EF-B2-1	CUSTODIAL RM B-202	CUSTODIAL RM B-202	CEILING MOUNT	75	0.25	-	879	-	0.6	6W	115	1	1725	GREENHECK / SP-80-VG	16	SEE BELOW

REMARKS:

1. ALL FANS SHALL BE BALANCED TO AIRFLOW QUANTITY INDICATED ON PLANS AT INLETS AND OUTLETS.
2. PROVIDE SPEED CONTROLLERS.
3. PROVIDE BACKDRAFT DAMPERS.
4. PROVIDE VIBRATION ISOLATION.
5. PROVIDE FACTORY WIRED DISCONNECT SWITCHES.
6. PROVIDE GREENHECK BRICK VENT TERMINATION MODEL EX.
14. PROVIDE CONTROL AND MONITORING CAPABILITY THROUGH A BUILDING MANAGEMENT CONTROL SYSTEM.
15. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION AND REQUIREMENTS.

REGISTERS, GRILLES & DIFFUSERS

SYM	SERVICE	TYPE	MAKE	MODEL	MATERIAL FINISH	NECK SIZE (W"xH")	FACE SIZE (W"xH")	CFM RANGE	BORDER TYPE	NC LEVEL (MAXIMUM)	ACCESSORIES	REMARKS
A	SUPPLY	CD	TITUS	TDC	BY ARCH	6"Ø	24x24	0-100	BY ARCH	25		SEE BELOW
						8"Ø	24x24	101-220				
						10"Ø	24x24	221-350				
						12"Ø	24x24	351-470				
						14"Ø	24x24	471-640				
						16"Ø	24x24	641-840				
B	EXHAUST /RETURN	TR	TITUS	355 RL	STEEL	10x10	12x12	101-450	BY ARCH	25		SEE BELOW
C	SUPPLY	TR	TITUS	272 RL	STEEL	12x6	14x8	0-300	BY ARCH	25		SEE BELOW
						20x6	22x8	301-500				
						18x10	20x12	501-850				

REMARKS:

1. PROVIDE ALL NECESSARY ACCESSORIES FOR INSTALLATION INTO ARCHITECTURAL CEILING. REFER TO ARCHITECTURAL DRAWINGS FOR CEILING TYPES.
2. PER ACOUSTICAL CONSULTANT REQUIREMENTS MAXIMUM VELOCITY THROUGH REGISTERS, GRILLES AND DIFFUSERS SHALL BE:
   a. 500 FPM FOR CLASSROOMS
   b. 500 FPM FOR SUPPLY IN OTHER AREAS
   c. 600 FPM FOR EXHAUST/RETURN IN OTHER AREAS.
3. AREAS SUCH AS THE AUDITORIUM, CAFETERIA, CORRIDORS WITH CURVED CEILINGS, GYMNASIUM AND OTHER EXPOSED DUCTWORK AREAS SHALL BE PAINTED. COLORS BY ARCHITECT.
4. CURVED OUTLETS AND PLENUMS SHALL MATCH THE CURVATURE OF THE ARCHITECTURAL CEILING.

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES
3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision: Description: Date: Revised By:

Drawing Title:
BUILDING "B"
MECHANICAL SCHEDULES
State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: WJY
Project Number: 22.335

Drawing Number: M301

MITSUBISHI ELECTRIC TRANE HVAC US: CITY MULTI VRF INDOOR UNIT SCHEDULE

System Tag	Room Name	Tag Reference	Model	Type	Nominal Cooling Capacity (BTU/h)	Nominal Heating Capacity (BTU/h)	Cooling Design Entering Temp DB/WB (°F) / [Water in temp]	Heating Design Entering Temp DB/WB (°F) / [Water in temp]	Corrected Capacity					Estimated Cooling Coil LAT (°F) / [LWT]	Estimated Heating Coil LAT (°F) / [LWT]	Refrig Pipe Dim Liquid/Suction (inch)	Fan Speed Setting	Peak Fan Airflow (cfm) / [Design gpm G(US)/min]	Max Fan ESP Setting 208V/230V (IN WG)	Voltage / Phase	Power Cooling 208V/230V (kW)	Power Heating 208V/230V (kW)	Electrical MCA/MFS	Remarks
									Cooling Diversity Full/Partial (See Note 5, 6)	Cooling Total Capacity (BTU/h)	Cooling Sensible Capacity (BTU/h)	Heating Diversity Full/Partial (See Note 5, 6)	Heating Capacity (BTU/h)											
2nd Floor North		FCU-B2-0	TPLFYP006EM140B	Ceiling-Cassette (Four-Way)	6,000	6,700	80.0/67.0	70	PARTIAL DEMAND	6,012.3	5,091.1	FULL DEMAND	6,695.5	70.3	82.6	1/4 / 1/2	HIGH	494		208/230V/1-phase	0.02	0.02	0.24/0.19/15	See Below
2nd Floor North		FCU-B2-1A	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,986.7	53.8	112.3	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
2nd Floor North		FCU-B2-1B	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,986.7	53.8	112.3	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
2nd Floor North		FCU-B2-2A	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,986.7	53.8	112.3	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
2nd Floor North		FCU-B2-2B	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,986.7	53.8	112.3	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
2nd Floor North		FCU-B2-6A	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
2nd Floor North		FCU-B2-6B	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
2nd Floor North		FCU-B2-7A	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
2nd Floor North		FCU-B2-7B	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
2nd Floor South		FCU-B2-3A	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,661.2	53.8	111.6	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
2nd Floor South		FCU-B2-3B	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,661.2	53.8	111.6	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
2nd Floor South		FCU-B2-4A	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,661.2	53.8	111.6	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
2nd Floor South		FCU-B2-4B	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,661.2	53.8	111.6	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
2nd Floor South		FCU-B2-5	TPKFYP012LM140A	Wall -Mounted	12,000	13,500	80.0/67.0	70	PARTIAL DEMAND	12,024.5	8,101.8	FULL DEMAND	13,271.3	54.2	111.4	1/4 / 1/2	HIGH	297		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
2nd Floor South		FCU-B2-8A	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,712.0	53.5	113.9	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
2nd Floor South		FCU-B2-8B	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,712.0	53.5	113.9	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
2nd Floor South		FCU-B2-9A	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,712.0	53.5	113.9	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
2nd Floor South		FCU-B2-9B	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,712.0	53.5	113.9	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
1st Floor North		FCU-B1-0	TPLFYP006EM140B	Ceiling-Cassette (Four-Way)	6,000	6,700	80.0/67.0	70	PARTIAL DEMAND	6,012.3	5,091.1	FULL DEMAND	6,695.5	70.3	82.6	1/4 / 1/2	HIGH	494		208/230V/1-phase	0.02	0.02	0.24/0.19/15	See Below
1st Floor North		FCU-B1-1A	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,986.7	53.8	112.3	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
1st Floor North		FCU-B1-1B	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,986.7	53.8	112.3	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
1st Floor North		FCU-B1-2A	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,986.7	53.8	112.3	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
1st Floor North		FCU-B1-2B	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,986.7	53.8	112.3	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
1st Floor North		FCU-B1-6A	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
1st Floor North		FCU-B1-6B	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
1st Floor North		FCU-B1-7A	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
1st Floor North		FCU-B1-7B	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
1st Floor South		FCU-B1-3A	TPKFYP024KM142A	Wall -Mounted	24,000	27,000	80.0/67.0	70	PARTIAL DEMAND	24,049.1	19,628.5	FULL DEMAND	26,982.0	59.8	97.2	3/8 / 5/8	HIGH	918		208/230V/1-phase	0.07	0.07	0.63(208V)/0.63(230V)/15	See Below
1st Floor South		FCU-B1-4A	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,986.7	53.8	112.3	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
1st Floor South		FCU-B1-4B	TPKFYP018LM140A	Wall -Mounted	18,000	20,000	80.0/67.0	70	PARTIAL DEMAND	18,036.8	12,129.3	FULL DEMAND	19,986.7	53.8	112.3	1/4 / 1/2	HIGH	438		208/230V/1-phase	0.05	0.04	0.24/0.24/15	See Below
1st Floor South		FCU-B1-5	TPKFYP012LM140A	Wall -Mounted	12,000	13,500	80.0/67.0	70	PARTIAL DEMAND	12,024.5	8,101.8	FULL DEMAND	13,491.0	54.2	112.1	1/4 / 1/2	HIGH	297		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
1st Floor South		FCU-B1-8A	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
1st Floor South		FCU-B1-8B	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
1st Floor South		FCU-B1-9A	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below
1st Floor South		FCU-B1-9B	TPKFYP015LM140A	Wall -Mounted	15,000	17,000	80.0/67.0	70	PARTIAL DEMAND	15,030.7	9,905.6	FULL DEMAND	16,988.7	53.5	114.6	1/4 / 1/2	HIGH	353		208/230V/1-phase	0.04	0.03	0.24/0.24/15	See Below

REMARKS:

1. NOMINAL COOLING CAPACITIES ARE BASED ON INDOOR COIL EAT OF 80/67°F (DB/WB), OUTDOOR OF 95°F (DB).
2. NOMINAL HEATING CAPACITIES ARE BASED ON INDOOR COIL EAT OF 70°F (DB), OUTDOOR OF 43°F (WB).
3. SEE OUTDOOR UNIT SCHEDULE FOR OUTDOOR AMBIENT CONDITIONS, CONNECTED CAPACITY, AND OTHER FACTORS ASSOCIATED WITH CORRECTED CAPACITIES.
4. SEE SCHEMATIC PIPING/CONTROL DIAGRAM FOR INDICATION OF REQUIRED INDOOR UNIT REMOTE CONTROLLERS, SYSTEM CONTROLLERS, AND INTEGRATION DEVICES.
5. FULL DEMAND CORRECTED CAPACITY INCLUDES DE-RATE ASSOCIATED WITH INDOOR VS. OUTDOOR CONNECTED CAPACITY INDICATED ON OUTDOOR UNIT SCHEDULE FOR ASSOCIATED SYSTEM. PARTIAL CORRECTED CAPACITY ASSUMES SUFFICIENT DIVERSITY EXISTS SUCH THAT THE CONNECTED CAPACITY DE-RATE DOES NOT APPLY. IT IS THE DESIGNER'S RESPONSIBILITY TO ENSURE "DIAMOND SYSTEM BUILDER" IS SET IN THE APPROPRIATE OUTPUT CAPACITY SETTING (FULL DEMAND/PARTIAL DEMAND) PRIOR TO GENERATING THIS SCHEDULE.
6. IT IS RECOMMENDED TO ALWAYS BASE HEATING CORRECTED CAPACITY ON FULL DEMAND.
7. UNIT SHALL UTILIZE R-410A REFRIGERANT. R-22 REFRIGERANT IS NOT ACCEPTABLE.
8. UNITS SHALL BE EQUIPPED WITH INTEGRAL CONDENSATE LIFT MECHANISMS AND SENSORS.
9. REFER TO OUTDOOR UNIT, BRANCH CIRCUIT CONTROLLER ON SCHEDULES FOR ADDITIONAL INFORMATION ASSOCIATED WITH THE VRF SYSTEM.
10. PROVIDE CEILING TRIM PANEL PLFY-ITP1 TO FIT WITHIN ARCHITECTURAL LAY-IN CEILINGS.
11. PROVIDE MULTI-FUNCTIONAL CASEMENT M3 PAC-SJ41TM-E ON CEILING CASSETTE UNITS REQUIRING MORE THAN 50 CFM OF OUTSIDE AIR.
12. PROVIDE XB7-721 BLUE DIAMOND MAXBLUE CONDENSATE PUMP (CP-1) WITH A DPLS DRAIN PAN LEVEL SENSOR AND WALL MOUNT SUPPORTS FOR EACH UNIT. PUMP SHALL BE HARD WIRED TO INDOOR UNIT.
13. EQUIPMENT MUST BE PURCHASED FROM A COMMERCIAL SALES OFFICE THAT OFFERS FULL SALES, TECHNICAL SUPPORT AND HAS FULL SERVICE OPERATION WITH A MINIMUM OF (10) SERVICE TRUCKS. THE COMMERCIAL SALES OFFICE SHALL HAVE ACCESS TO ELECTRONIC SALES, SERVICE AND TECHNICAL SOFTWARE FOR COMPLETE SUBMITTAL PACKAGES AND AFTER-MARKET SUPPORT.
14. PROVIDE CONTROL AND MONITORING CAPABILITY THROUGH A BUILDING MANAGEMENT SYSTEM. PROVIDE FACTORY MOUNTED BACNET DDC UNIT CONTROLLER.
15. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION AND REQUIREMENTS.

VRF HEAT RECOVERY BRANCH CIRCUIT CONTROLLER

System Tag	Tag Reference	M-NET Address	Model Number	Type (double / Main / Sub)	Number of Ports	Connected Capacity to BC	Voltage / Phase	MCA 208/230	Remarks
2nd Floor North	BC-1	53	TCMBM0108JA11N4	Main	8	138,000.0	208/230V/1-phase	0.30 / 0.35	See Below
2nd Floor South	BC-2	62	TCMBM0108JA11N4	Main	8	144,000.0	208/230V/1-phase	0.30 / 0.35	See Below
1st Floor North	BC-3	71	TCMBM0108JA11N4	Main	8	138,000.0	208/230V/1-phase	0.30 / 0.35	See Below
1st Floor South	BC-4	80	TCMBM0108JA11N4	Main	8	132,000.0	208/230V/1-phase	0.30 / 0.35	See Below

REMARKS:

1. INCLUDE DIAMONDBACK BALL VALVES BV-SERIES, 700PSIG WORKING PRESSURE, FULL PORT, 410A RATED.
2. PROVIDE ISOLATION VALVES OFF EACH UNIT AND PIPING TEE. (FOR EACH ZONE).
3. FOR SUB BC CONTROLLER CMB-P-NU-GB1.0R -GB, THE TOTAL CONNECTABLE INDOOR UNIT CAPACITY CAN BE 126,000 BTUs OR LESS. IF TWO (2) SUB BC CONTROLLERS ARE USED, THE TOTAL INDOOR UNIT CAPACITY CONNECTED TO BOTH SUB BC CONTROLLERS ALSO CANNOT EXCEED 126,000 BTUs. FOR SUB BC CONTROLLER CMB-P1016NU-HB1 THE TOTAL CONNECTABLE INDOOR UNIT CAPACITY CAN BE 126,000 BTUs OR LESS. HOWEVER, IF TWO (2) SUB CONTROLLERS ARE USED, AND ONE (1) OF THEM IS CMB-1016NU-HB1, THE TOTAL INDOOR UNIT CAPACITY CONNECTED TO BOTH SUB CONTROLLERS MUST NOT EXCEED 168,000 BTUs.

MITSUBISHI ELECTRIC TRANE HVAC US: CITY MULTI VRF OUTDOOR UNIT SCHEDULE

System Tag	Tag Reference	M-NET Address	Model Number	Modules	Nominal Cooling Capacity (BTU/h)	Nominal Heating Capacity (BTU/h)	Cooling Efficiency IEER/EER [SEER]	Heating COP @ 47°F [HSPF]	Nom System Connected Capacity (% of NOM)	Design Cooling Outdoor Temp DB (°F)	Design Heating Outdoor Temp WB (°F)	Max Pipe Length from BC or 1st Joint (feet)	Refrig Pipe Dim High/Low Pressure (inch) (See Note 4)	Corrected Cooling Total Capacity (BTU/h)	Corrected Heating Capacity (BTU/h)	Electrical-Per Module				NET Weight (lbs)	Remarks
																208/230 or [460V]					
																Voltage / Phase	MCA 208/230 or [460V]	RFS	MOCP		
2nd Floor North	HP-1	51, 52	TURYH1444BN40AN	P72, P72	144,000	160,000	22.1 / 11.55	3.635	95.8 %	88.0	2.3	61.6	7/8 / 1-1/8	144,242.0	158,764.1	460V / 3-phase 3-wire	17, 17	25, 25	25, 25	1288	See Below
2nd Floor South	HP-2	60, 61	TURYH1444BN40AN	P72, P72	144,000	160,000	22.1 / 11.55	3.635	100.0 %	88.0	2.3	61.6	7/8 / 1-1/8	142,117.3	158,764.1	460V / 3-phase 3-wire	17, 17	25, 25	25, 25	1288	See Below
1st Floor North	HP-3	69, 70	TURYH1444BN40AN	P72, P72	144,000	160,000	22.1 / 11.55	3.635	95.8 %	88.0	2.3	61.6	7/8 / 1-1/8	144,242.0	158,764.1	460V / 3-phase 3-wire	17, 17	25, 25	25, 25	1288	See Below
1st Floor South	HP-4	78, 79	TURYH1444BN40AN	P72, P72	144,000	160,000	22.1 / 11.55	3.635	91.7 %	88.0	2.3	61.6	7/8 / 1-1/8	146,366.7	158,764.1	460V / 3-phase 3-wire	17, 17	25, 25	25, 25	1288	See Below

REMARKS:

1. NOMINAL COOLING CAPACITIES ARE BASED ON INDOOR COIL EAT OF 80/67°F (DB/WB), OUTDOOR OF 95°F (DB).
2. NOMINAL HEATING CAPACITIES ARE BASED ON INDOOR COIL EAT OF 70°F (DB), OUTDOOR OF 43°F (WB).
3. EFFICIENCY VALUES FOR EER, IEER, COP ARE BASED ON AHRI 1230 TEST METHOD FOR MIXTURE OF DUCTED & NON-DUCTED INDOOR UNITS.
4. FOR SYSTEMS WITH MULTIPLE MODULES, REFRIGERANT PIPE DIMENSIONS INDICATE TOTAL SYSTEM COMBINED PIPING DOWNSTREAM OF MODULE TWINNING.
5. ADDED FIELD CHARGE LISTED IS IN ADDITION TO FACTORY CHARGE, THIS MUST BE UPDATED BASED UPON FINAL AS-BUILT PIPING LAYOUT.
6. THE COMPRESSORS SHALL UTILIZE R-410A REFRIGERANT. R-22 REFRIGERANT IS NOT ACCEPTABLE.
7. THE UNIT SHALL BE EQUIPPED WITH THE FOLLOWING: FIELD INSTALLED FILTER DRIER, FRONT SEAT SERVICE VALVES, INTERNAL PRESSURE RELIEF VALVE, LONG LINE CAPABILITY, LOSS OF CHARGE SWITCH, HIGH PRESSURE SWITCH, CRANKCASE HEATER, SNOW STAND HEAD PRESSURE CONTROL AND EVAPORATOR DEFROST CONTROL.
8. PROVIDE SNOW/HAIL GUARDS ON ALL UNITS. UNITS MOUNTED ON ROOF SHALL BE EQUIPPED WITH ONLY SIDE SNOW/HAIL GUARDS.
9. PROVIDE FACTORY DRAIN PAN HEATER.
9. CONTRACTOR TO FINALIZE REFRIGERANT PIPE SIZES WITH EQUIPMENT MANUFACTURER BASED ON ACTUAL LAYOUT.
10. UNIT SHALL BE CAPABLE OF OPERATION AT OUTDOOR AMBIENT TEMPERATURE FROM 0°F TO 110°F.
11. EQUIPMENT MUST BE PURCHASED FROM A COMMERCIAL SALES OFFICE THAT OFFERS FULL SALES, TECHNICAL SUPPORT AND HAS FULL SERVICE OPERATION WITH A MINIMUM OF (10) SERVICE TRUCKS. THE COMMERCIAL SALES OFFICE SHALL HAVE ACCESS TO ELECTRONIC SALES, SERVICE AND TECHNICAL SOFTWARE FOR COMPLETE SUBMITTAL PACKAGES AND AFTER-MARKET SUPPORT.
12. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION AND REQUIREMENTS.
13. PROVIDE CONCRETE CURBS FOR UNITS MOUNTED AT GRADE.
14. PROVIDE ROOF SUPPORTS/STANDS FOR UNITS MOUNTED ON ROOF. REFER TO DETAILS.

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES

3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
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Revision:	Description:	Date:	Revised By:

Drawing Title:

BUILDING "B"
MECHANICAL SCHEDULES

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: WJY
Project Number: 22.335

Drawing Number: M302

PIPE HANGER SPACING TABLE

PIPE MATERIAL	PIPE SIZES (INCHES)	HORIZONTAL PIPE MAX. HANGER DISTANCE (FT)	VERTICAL PIPE MAX. HANGER DISTANCE (FEET)
COPPER & COPPER ALLOY TUBING	1-1/4" & SMALLER	6'-0"	10'-0"
COPPER & COPPER ALLOY TUBING	1-1/2" & LARGER	10'-0"	10'-0"
COPPER & COPPER ALLOY PIPE	ALL	12'-0"	10'-0"
CAST IRON PIPE	ALL	5'-0" *	15'-0"
STEEL PIPE	ALL	12'-0"	15'-0"
STAINLESS STEEL DRAINAGE	ALL	10'-0"	10'-0 * *
CPVC PIPE OR TUBING	1" & SMALLER	3'-0"	10'-0 * *
CPVC PIPE OR TUBING	1-1/4" & LARGER	4'-0"	10'-0 * *
PVC PIPE	ALL	4'-0"	10'-0 * *

NOTES: (ALL PRODUCTS INDICATED WITHIN SCHEDULE ARE NEW EQUIPMENT)
* MAXIMUM HORIZONTAL SPACING OF CAST IRON PIPE HANGERS SHALL BE INCREASED TO 10'-0" WHERE 10'-" LENGTHS OF PIPE ARE USED

** MIDSTORY GUIDE FOR SIZES 2" AND SMALLER

NOT ALL PIPE MATERIALS ON THIS TABLE WILL PERTAIN TO THIS PROJECT

DUCT MATERIAL SCHEDULE

APPLICATION	SUPPLY	RETURN	EXHAUST
TYPICAL (UNLESS OTHERWISE SPECIFIED)	G90 GALVANIZED STEEL	G90 GALVANIZED STEEL	G90 GALVANIZED STEEL
EXPOSED AND CONCEALED EXHAUST DUCTWORK AND PLENUMS SERVING TOILET ROOMS, SHOWER ROOMS, CLOTHES DRYER, ALL DUCTWORK RUNNING THROUGH, OVER OR SERVING SHOWER ROOMS, HATCHERIES, AND ALL SPACES WITH OPEN TANKS.	3003 H-14 ALUMINUM	3003 H-14 ALUMINUM	3003 H-14 ALUMINUM
EXPOSED DUCTWORK LOCATED IN AND SERVING AIR-CONDITIONED SPACES TO BE FIELD PAINTED OTHER THAN DUCTWORK LOCATED IN SPACES REQUIRED TO BE ALUMINUM.	A60 GALVANNEALED STEEL	A60 GALVANNEALED STEEL	A60 GALVANNEALED STEEL
EXPOSED DUCTWORK LOCATED IN AND SERVING CONDITIONED SPACES OTHER THAN DUCTWORK LOCATED IN SPACES REQUIRED TO BE ALUMINUM.	G90 GALVANIZED STEEL	G90 GALVANIZED STEEL	G90 GALVANIZED STEEL
EXPOSED DUCTWORK LOCATED IN AND SERVING CONDITIONED SPACES OTHER THAN DUCTWORK LOCATED IN SPACES REQUIRED TO BE ALUMINUM OR TO BE FIELD PAINTED.	G90 GALVANIZED STEEL	G90 GALVANIZED STEEL	G90 GALVANIZED STEEL

1. DUCT CONSTRUCTION SHALL MEET SMACNA "HVAC DUCT CONSTRUCTION STANDARDS METAL & FLEXIBLE" 2020 4TH EDITION STANDARDS.

DUCT INSULATION SCHEDULE

SYSTEM	INSULATION TYPE	MINIMUM INSTALLED INSULATION VALUES	NOMINAL DENSITY
	MINERAL FIBER BLANKET	R-6	3/4 LB/FT^3
INDOOR DUCT/PLENUM CONCEALED SA, RA, OA: OTHER THAN PRE-MANUFACTURED LINEAR SUPPLY AND RETURN GRILLE PLENUMS.	MINERAL FIBER BOARD WITH REFLECTIVE VAPOR BARRIER.	R-6	3 LB/FT^3
INDOOR DUCT/PLENUM EXPOSED SA AND RA: LOCATED IN MECHANICAL ROOMS, OTHER NON-OCCUPIED SPACES, NON-AIR CONDITIONED SPACES, PASSING THROUGH AIR CONDITIONED SPACES.	MINERAL FIBER BOARD WITH REFLECTIVE VAPOR BARRIER.	R-6	3 LB/FT^3
DUCT LINING DUCTS INSTALLED IN INDOOR SPACES: EXPOSED AND CONCEALED SA OR RA DUCTWORK WHERE INDICATED ON THE DRAWINGS AND IN THE SPECIFICATION, 15 FT DOWNSTREAM OF SUPPLY FANS, RETURN FANS AND 10 FT DOWNSTREAM OF TERMINAL BOXES WHETHER INDICATED OR NOT.	FIBROUS-GLASS DUCT LINER WITH CLEANABLE COMPOSITE COATING ON AIRSTREAM SIDE. METAL NOSING SHALL BE FURNISHED ON ALL LEADING AND LEAVING EDGES. (REFER TO NOTES #2, #4)	R-6	3 LB/FT^3
ABOVEGROUND, OUTDOOR DUCT/PLENUM CONCEALED OR EXPOSED SA, RA, AND OA.	MINERAL FIBER BOARD (REFER TO NOTE #1)	R-12	3 LB/FT^3

1. FOR OUTDOOR DUCTWORK PROVIDE A PRE-MANUFACTURED SELF ADHERING PRODUCT WITH AN UV RESISTANT, STUCCO EMBOSSED FACING. WATER VAPOR TRANSMISSION OF THE INSTALLED PRODUCT SHALL BE .020 PERMS OR LESS. PRODUCT SHALL BE SUITABLE FOR CONTINUOUS USE IN LOW TEMPERATURES OF -10°F. MANUFACTURERS SHALL BE SIMILAR TO FLEX-CLAD 400, MFM BUILDING PRODUCTS CORP. OR ALUMAGUARD 60, POLYGUARD PRODUCTS, INC.

2. DUCT LINING SHALL NOT BE INSTALLED WITHIN 10 FT UPSTREAM OR DOWNSTREAM OF A DUCT MOUNTED HUMIDIFIER DISPERSION TUBE OR DISPERSION GRID.

3. INSULATION TYPES INDICATED IN THE SCHEDULE SHALL USED UNLESS OTHERWISE INDICATED ON THE PLANS OR SPECIFICATIONS.

4. CLOSED CELL, FIBER FREE, ANTI-MICROBIAL COATED, LOW VOC CERTIFIED, MOISTURE AND MOLD RESISTANT DUCT LINING SHALL BE PROVIDED IN DUCTWORK AND EQUIPMENT WITHIN HOSPITAL AND HEALTHCARE FACILITIES AND ROOMS CLASSIFIED AS MOIST OR WET ENVIRONMENTS WHERE THIS SCHEDULE, DRAWINGS AND SPECIFICATION INDICATE DUCT LINING.

ABBREVIATIONS:

OA = OUTDOOR AIR DUCTWORK
SA = SUPPLY AIR DUCTWORK
RA = RETURN AIR DUCTWORK
EA = EXHAUST AIR DUCTWORK

PIPE/TUBE PIPING AND FITTING SCHEDULE

SYSTEM	PIPE SIZE	CONSTRUCTION	PIPING	FITTINGS	UNIONS	FLANGES
COOLING COIL CONDENSATE DRAINS	2" AND SMALLER	SOLDER JOINT CONSTRUCTION WITH THREADED ADAPTERS AS REQUIRED. 95-5 TIN/ANTIMONY SOLDER.	COPPER, TYPE L, HARD DRAWN, ANSI H23.1, ASTM B88.	CAST BRONZE OR WROUGHT COPPER, SOLDER ENDS, ANSI B16.9 OR ANSI B16.22.	BRONZE SOLDER ENDS, GROUND JOINTS, ANSI B16.19 OR ANSI B16.22.	USE UNIONS
	2 1/2" AND LARGER	SOLDER JOINT CONSTRUCTION WITH THREADED ADAPTERS AS REQUIRED. 95-5 TIN/ANTIMONY SOLDER.	COPPER, TYPE L, HARD DRAWN, ANSI H23.1, ASTM B88.	CAST BRONZE OR WROUGHT COPPER, SOLDER ENDS, ANSI B16.9 OR ANSI B16.22.	BRONZE SOLDER ENDS, GROUND JOINTS, ANSI B16.19 OR ANSI B16.22.	USE UNIONS
REFRIGERANT SUCTION, HOT GAS AND LIQUID PIPING AND TUBING	2" AND SMALLER	BRAZED JOINT CONSTRUCTION. AWS A5.8 FILLER METAL.	COPPER, ACR TUBING, STRAIGHT LENGTHS, DRAWN H58, ASTM B 280.	WROUGHT COPPER, BRAZED ENDS, ANSI B16.22.	WROUGHT COPPER, BRAZED ENDS, ANSI B16.22.	USE UNIONS
	2 1/2" AND LARGER	BRAZED JOINT CONSTRUCTION. AWS A5.8 FILLER METAL.	COPPER, ACR TUBING, STRAIGHT LENGTHS, DRAWN H58, ASTM B 280.	WROUGHT COPPER, BRAZED ENDS, ANSI B16.22.	WROUGHT COPPER, BRAZED ENDS, ANSI B16.22.	USE UNIONS

PIPE/TUBE INSULATION SCHEDULE

SYSTEM	LOCATION	PIPE SIZE	CELLULAR GLASS	FLEXIBLE ELASTOMERIC	MINERAL-FIBER TYPE 1	CALCIUM SILICATE
CONDENSATE & EQUIPMENT DRAIN, BELOW 60°F	INDOOR	ALL	1-1/2"	--	1/2"	--
	OUTDOOR	ALL	1-1/2"	--	--	--
REFRIGERANT (ALL) SUCTION, HOT GAS, VAPOR, & LIQUID PIPING	INDOOR	ALL	2"	2"	2"	--
	OUTDOOR	ALL	2"	2"	--	--
REFRIGERANT (ALL) SUCTION, HOT GAS, VAPOR, & LIQUID FLEXIBLE TUBING	INDOOR	ALL	--	2"	--	--
	OUTDOOR	ALL	--	2"	--	--

BLANKS (-) INDICATE INSULATION TYPE SHALL NOT BE USED.
THICKNESS BASED ON INSULATION HAVING A CONDUCTIVITY (K) NOT EXCEEDING 0.27 BTU PER INCH/HR·FT^2·°F.

1. ALL EXPOSED INDOOR PIPING/TUBING AND FITTINGS WITHIN OCCUPIED SPACES, CORRIDORS, MECHANICAL ROOMS AND OTHER NON-CONCEALED LOCATIONS SHALL BE FITTED WITH PVC FITTING COVERS AND PVC PIPE COVERS FROM THE FLOOR LEVEL TO 12' ABOVE THE FINISHED FLOOR. PVC FITTING AND PIPE COVERS SHALL BE 25/50 FLAME AND SMOKE SPREAD RATED. COVERS AND JACKETING COLOR TO BE SELECTED BY ARCHITECT. PROVIDE TEMPLATE OF JACKET COLORS FOR THE ARCHITECT'S REVIEW.

2. ALL ELBOWS; CONCEALED OR EXPOSED, SHALL BE INSULATED WITH PRE-MOLDED, FACTORY FORMED FIBROUS GLASS WITH 3.5 PCF MINIMUM DENSITY AS MANUFACTURED BY HAMFAB OR APPROVED EQUAL. ALL ELBOWS; CONCEALED OR EXPOSED, SHALL BE COVERED WITH PVC FITTING COVERS. PVC FITTING COVERS SHALL BE 25/50 FLAME AND SMOKE SPREAD RATED. COVER COLOR TO BE SELECTED BY ARCHITECT. PROVIDE TEMPLATE OF JACKET COLORS FOR THE ARCHITECT'S REVIEW.

3. DIAPER AND LOOSE FILL STYLE INSULATION ON PIPE FITTINGS IS NOT ACCEPTABLE. ELBOWS WITHOUT PVC COVERS ARE NOT ACCEPTABLE.

4. ALL OUTDOOR PIPING/TUBING SHALL BE FITTED WITH A PRE-MANUFACTURED ALUMINUM JACKET PRODUCT. 0.024" ALUMINUM JACKET LOCK-ON OR SLIP-ON TYPE JACKETING TO BE COVERED WITH ACRYLIC COATING ON THE OUTER SURFACE AND A BAKED EPOXY MOISTURE BARRIER ON THE INNER SURFACE. MANUFACTURER SHALL BE SIMILAR TO CHILDERS PRODUCTS, DIVISION OF ITW; METAL JACKETING SYSTEMS. ALL EXPOSED JOINTS IN THE JACKET PRODUCT SHALL BE INSTALLED IN SUCH A WAY AS TO PREVENT THE INFILTRATION OF MOISTURE AND WATER.

VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

EQUIPMENT	BASE	ISOLATOR*	SEISMIC RESTRAINT	DEFLECTION
CONDENSING UNITS (GRADE AND ROOF MOUNTED)	24" HIGH EQUIPMENT RAILS	NP	LAG BOLT TO RAIL. RAIL TO BE ATTACHED TO STRUCTURE.	0.2"
SUSPENDED INLINE FANS	--	HSN	CABLE RESTRAINTS	1.5"
PIPING WITHIN 50FT OF CONNECTION TO ANY PIECE OF EQUIPMENT WITH A MOTOR	--	HSN	--	1.2"

REMARKS:
1. REFER TO SPECIFICATION SECTION (230548) - "VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT" FOR A DESCRIPTION OF EACH VIBRATION CONTROL DEVICE.
2. (NP) - NEOPRENE PAD, (DNP) - DOUBLE NEOPRENE PAD, (FNC) - FLOOR NEOPRENE RESTRAINED MOUNTS, (FSN) - FLOOR SPRING AND NEOPRENE SPRING ISOLATOR, (FSNTL) - FLOOR SPRING AND NEOPRENE TRAVEL LIMITED RESTRAINED SPRING ISOLATOR, (HN) - NEOPRENE HANGER, (HSN) - SPRING AND NEOPRENE HANGER, (RC2) - ROOF CURB, TYPE 2, (BSF) - BASE, STEEL FRAME, (BIB) - BASE, INERTIA BASE, (FPC) - FLEXIBLE PIPE CONNECTIONS, (SRC) - SEISMIC ROOF CURB.

* IN ADDITION TO ANY INTERNAL VIBRATION ISOLATION.
** SYSTEM SHALL BE DESIGNED TO BE 90% EFFICIENT.

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES
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Revision: Description: Date: Revised By:

Drawing Title:
BUILDING "B"
MECHANICAL SCHEDULES
State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: WJY
Project Number: 22.335

Drawing Number: M303

CITY MULTI

SYSTEM SCHEMATIC DWG.

DIAGRAM SYMBOL LEGEND	
DISPLAY	DESCRIPTION
—///—	POWER WIRE
————	CONTROL WIRE
— —	REF. PIPE

CONT.No		PAGE	

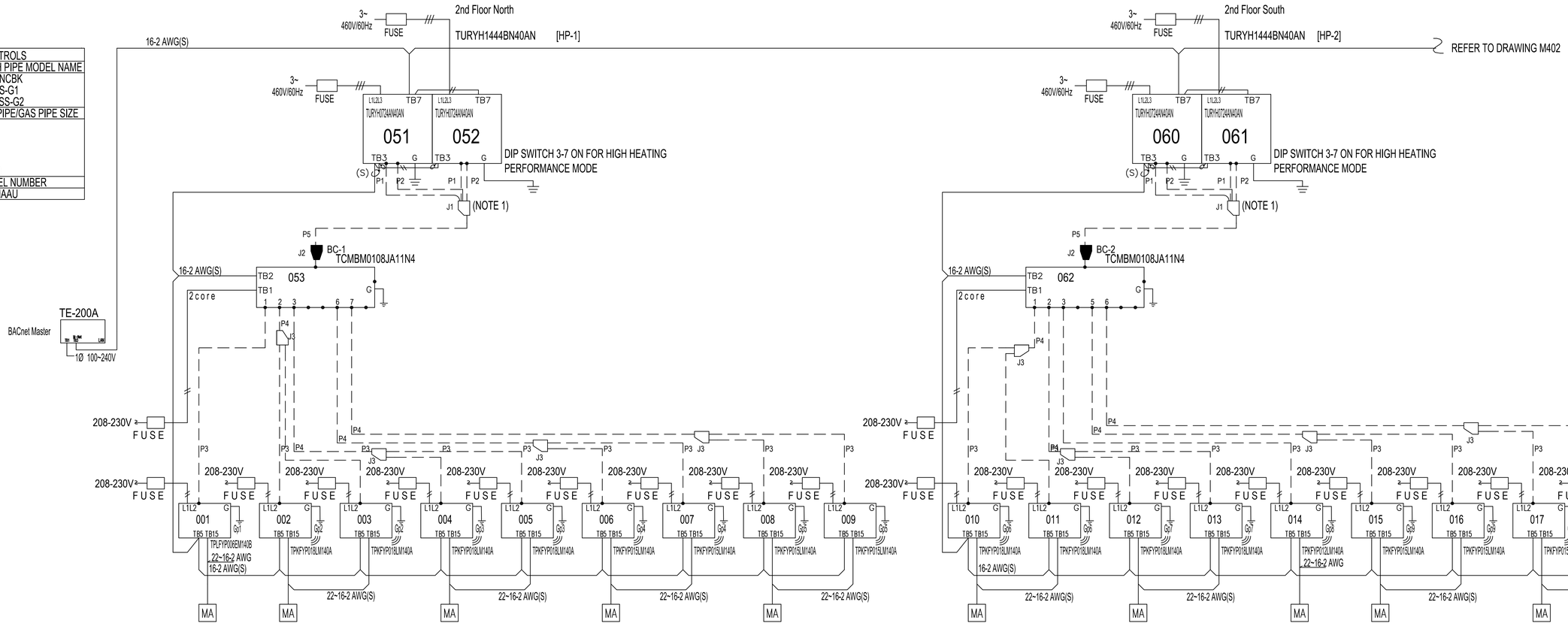
THIS DRAWING IS SCHEMATIC IN NATURE. FINAL ROUTING OF PIPING & WIRING SHALL BE DETERMINED BY THE INSTALLING CONTRACTOR AND/OR DESIGNER OF RECORD ADDITIONAL REFRIGERANT CHARGE IS NEEDED DEPENDING ON THE SIZE AND LENGTH OF EXTENDED PIPING. PLEASE REFER THE AMOUNT OF PRE-CHARGE AND THE FORMULA OF CALCULATION WHICH IS MENTIONED ON THE DATA BOOK.

1.25mm²(16 AWG) : 1.25mm²(16 AWG) or more. 0.75mm²(20 AWG) : between 0.5mm²(24 AWG) and 0.75mm²(20 AWG).

CODED NOTES:

NOTE 1: INSTALL TWINNING Y'S WITHIN 15 DEGREES OF LEVEL AND WITH 20 INCHES OF STRAIGHT PIPE ON CONVERGING CONNECTION - REFERENCE INSTALLATION MANUAL FOR ADDITIONAL DETAILS INCLUDING BUT NOT LIMITED TO SPECIAL TRAPPING REQUIREMENTS WHEN TWINNING, AND PIPE SLOPE REQUIREMENTS

PIPING AND CONTROLS	
SYMBOL	BRANCH PIPE MODEL NAME
J1	CMY-R100NCBK
J2	CMY-R302S-G1
J3	CMY-Y102SS-G2
SYMBOL	LIQUID PIPE/GAS PIPE SIZE
P1	5/8 /
P2	/ 3/4
P3	1/4 / 1/2
P4	3/8 / 5/8
P5	7/8 / 1-1/8
SYMBOL	MODEL NUMBER
MA	TAR-40MAAU



WORK RM B-204	SP ED B-206	SP ED B-206	CLASS B-208	CLASS B-208	CLASS B-209	CLASS B-209	CLASS B-211	CLASS B-211
FCU-B2-0	FCU-B2-1A	FCU-B2-1B	FCU-B2-2A	FCU-B2-2B	FCU-B2-6A	FCU-B2-6B	FCU-B2-7A	FCU-B2-7B

CLASS B-210	CLASS B-210	CLASS B-212	CLASS B-212	L.C. B-214	CLASS B-213	CLASS B-213	CLASS B-215	CLASS B-215
FCU-B2-3A	FCU-B2-3B	FCU-B2-4A	FCU-B2-4B	FCU-B2-5	FCU-B2-8A	FCU-B2-8B	FCU-B2-9A	FCU-B2-9B

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

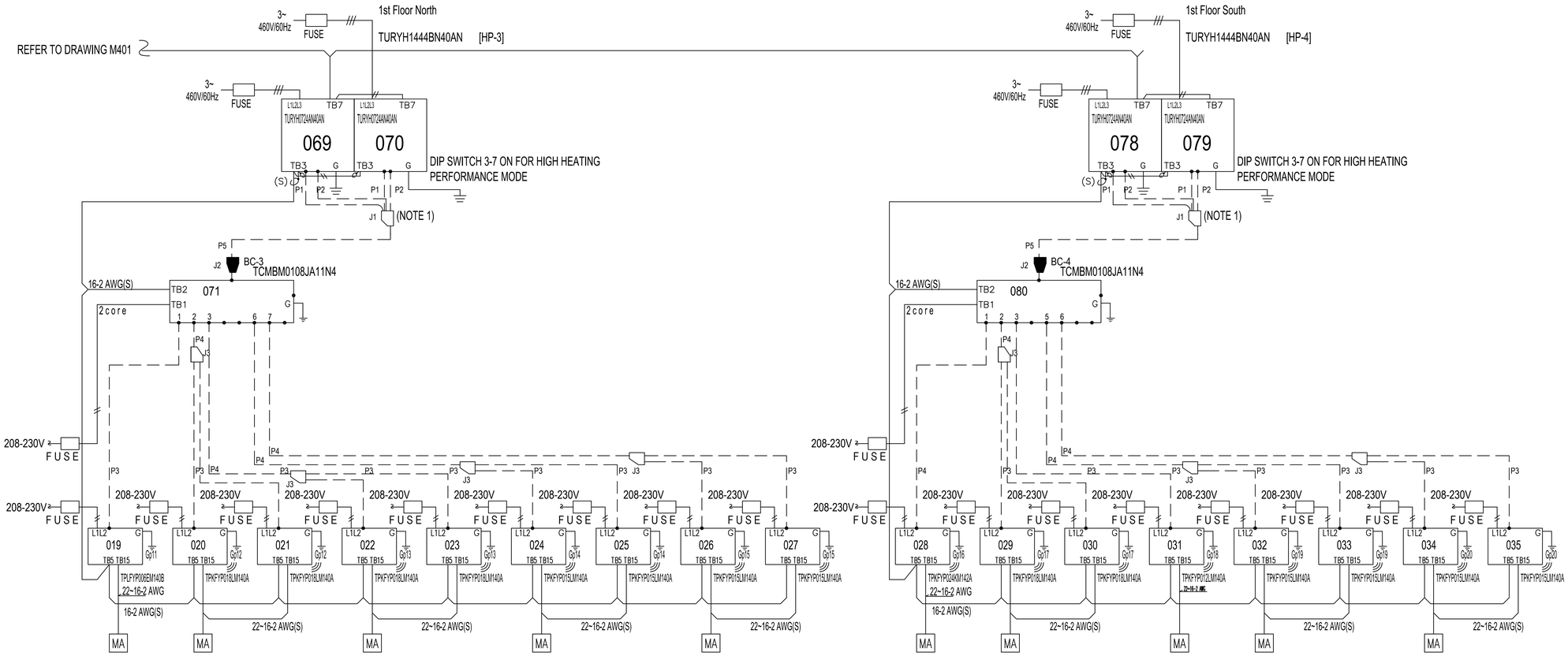
SILVER PETRUCELLI + ASSOCIATES
3190 WHITNEY AVENUE HAMDEN CT 06518
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Revision:	Description:	Date:	Revised By:

Drawing Title:
BUILDING "B"
MECHANICAL VRF SYSTEM DIAGRAMS
State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: WJY
Project Number: 22.335

Drawing Number: M401



WORK RM B-102, FCU-B1-0	SP ED B-106, FCU-B1-1A	SP ED B-106, FCU-B1-1B	CLASS B-108, FCU-B1-2A	CLASS B-108, FCU-B1-2B	CLASS B-109, FCU-B1-6A	CLASS B-109, FCU-B1-6B	CLASS B-111, FCU-B1-7A	CLASS B-111, FCU-B1-7B

CLASS B-110, FCU-B1-3A	CLASS B-110, FCU-B1-4A	CLASS B-112, FCU-B1-4B	L.C. B-114, FCU-B1-5	CLASS B-113, FCU-B1-8A	CLASS B-113, FCU-B1-8B	CLASS B-115, FCU-B1-9A	CLASS B-115, FCU-B1-9B	

Project Title:

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Trumbull, CT 06611

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Date: 2-09-2024
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DEMOLITION AND REMOVALS

1. THE EXISTING FACILITY WILL BE OCCUPIED AND IN OPERATION DURING THE PERFORMANCE OF THE WORK.
2. WHEN NECESSARY TO TEMPORARILY DISCONNECT ANY EXISTING FEEDER OR BRANCH CIRCUIT SUPPLYING OCCUPIED FACILITIES, CONFER WITH THE OWNER, AND SCHEDULE A MUTUALLY AGREEABLE PERIOD OF INTERRUPTION.
3. WHERE REPLACEMENT, RELOCATION OR MODIFICATION OF EXISTING EQUIPMENT IS INDICATED, PROVIDE AND MAINTAIN ALL TEMPORARY FEEDERS, CONNECTIONS, CIRCUIT PROTECTION, AND ANY OTHER MATERIALS AND APPURTENANCES REQUIRED TO MAINTAIN SERVICES TO OCCUPIED AREAS.
4. NO WORK SHALL BE LEFT INCOMPLETE, NOR ANY HAZARDOUS SITUATION CREATED, WHICH WILL AFFECT THE LIFE OR SAFETY OF THE PUBLIC AND/OR BUILDING OCCUPANTS. AT NO TIME SHALL THE WORK INTERFERE WITH OR CUT OFF ANY OF THE EXISTING SERVICES WITHOUT THE OWNER'S PRIOR WRITTEN PERMISSION.
5. THE OWNER RESERVES THE RIGHT TO OPERATE ALL EXISTING ELECTRICAL AND MECHANICAL EQUIPMENT NOT INCLUDED IN THIS WORK, AND TO PERFORM ALL REQUIRED SERVICING AND REPAIRS TO SAME, AT ALL TIMES.
6. IT IS REQUIRED THAT THE WORK INDICATED AND/OR SPECIFIED SHALL BE CARRIED OUT WITH A MINIMUM OF INTERFERENCE TO THE ESTABLISHED OPERATIONS OF THE BUILDING.
7. REMOVE, ABANDON, REROUTE, OR RELOCATE ANY CONDUIT, WIRING, LIGHTING FIXTURES, OUTLETS, AND OTHER ELECTRICAL ITEMS, WHICH ARE LAID BARE IN THE COURSE OF, OR INTERFERE WITH, THE ALTERATIONS. REMOVE ALL EXPOSED OUTLETS, CONDUIT, AND BRANCH CIRCUIT WORK, WHICH INTERFERE WITH THE ALTERATIONS.
8. IT IS THE INTENTION OF THESE SPECIFICATIONS TO PROVIDE FOR THE CONTINUANCE OF ALL ELECTRICAL SERVICES PRESENTLY INSTALLED IN THE UNALTERED AREAS. PROVIDE ALL CONDUIT, WIRING, AND DEVICES NECESSARY TO MAINTAIN SERVICES TO THESE AREAS.
9. COMPARE THE PLANS WITH THE EXISTING CONDITIONS TO DETERMINE THE AMOUNT OF WORK AFFECTED. REMOVE ALL UNUSED EXPOSED CIRCUIT WORK, OUTLETS, FIXTURES AND THE LIKE NOT REQUIRED BY THE ALTERATIONS.
10. ALL MATERIALS REQUIRED TO BE REMOVED AND NOT REINSTALLED UNDER THIS DIVISION OF THE WORK, UNLESS OTHERWISE INDICATED, SHALL BECOME THE PROPERTY OF THE CONTRACTOR, AND SHALL BE REMOVED FROM THE SITE.
11. WHERE FEEDERS AND BRANCH CIRCUITS OR DEVICES AND EQUIPMENT ARE INDICATED TO BE REMOVED, CONDUCTORS AND CABLES SHALL BE COMPLETELY REMOVED BACK TO THEIR SOURCE. EXPOSED OR ACCESSIBLE CONDUITS SHALL BE REMOVED COMPLETELY; CONDUITS EMBEDDED IN CONCRETE OR MASONRY SHALL BE CUT OFF FLUSH AND THE SURFACE PATCHED SMOOTH AND LEVEL.
12. REMOVED MATERIALS SHALL BE DISPOSED OF USING LICENSED CARTING SERVICE.
13. CONTRACTOR SHALL REMOVE ALL ELECTRICAL EQUIPMENT IN OR ON WALLS THAT ARE TO BE REMOVED - MAINTAIN CONTINUITY OF ALL EXISTING BRANCH CIRCUITRY TO EXISTING ROOMS NOT BEING RENOVATED. REWIRE ALL EXISTING BRANCH CIRCUITS (THAT ARE TO REMAIN) AS REQUIRED. REFER TO ARCHITECTURAL DEMOLITION DRAWINGS FOR WALLS BEING REMOVED - REFER TO CONSTRUCTION SCHEDULE FOR TIME DELAY.
14. CONDUIT IN EXISTING OR NEW CEILINGS THAT ARE NOT INTENDED FOR REUSE SHALL BE REMOVED BACK TO THE PANEL FROM WHICH IT ORIGINATES.
15. CONDUCTORS THAT ARE NOT DEEMED REUSABLE SHALL BE REMOVED BACK TO THE NEAREST JUNCTION BOX. WHERE THE ENTIRE CIRCUIT IS TO BE REMOVED, THE CONDUCTORS SHALL BE REMOVED BACK TO THE PANELBOARD FROM WHICH THEY ORIGINATE.
16. OUTAGES OF EXISTING ELECTRICAL (LIGHTING, POWER, AND SIGNAL) SYSTEMS NECESSITATED BY WORK OF ALL TRADES SHALL BE IN ACCORDANCE WITH FIELD SCHEDULES BY THE GENERAL CONTRACTOR AND OWNER - INCLUDE ALL ELECTRIC WORK OVERTIME AND SUPERVISION TO COMPLY - CONTRACTOR SHALL OBTAIN OWNER'S GENERAL CONTRACTOR'S APPROVAL PRIOR TO DISRUPTING OF EXISTING ELECTRICAL SYSTEM.
17. CONTRACTOR TO MAINTAIN CONTINUITY AND ACCESSIBILITY OF ALL EXISTING SYSTEMS AND SYSTEM EQUIPMENT FEEDERS WHICH MAY BE DISRUPTED FOR WORK OF ANY TRADE.
18. CONTRACTOR TO MAINTAIN CONTINUITY AND ACCESSIBILITY OF ALL EXISTING ELECTRICAL (POWER, LIGHTING, AND SIGNAL) SYSTEMS, EQUIPMENT FEEDERS AND BRANCH CIRCUITS ON FLOORS OR AREAS THAT ARE NOT AFFECTED BY DEMOLITION OR NEW CONSTRUCTION - REFER TO CONSTRUCTION SCHEDULE FOR ADDITIONAL INFORMATION.
19. ANY EXISTING ELECTRICAL WORK WHICH IS PULLED OUT OR CUT AWAY SHALL BE REMOVED FROM THE SITE AS DIRECTED BY THE GENERAL CONTRACTOR AND THE OWNER.
20. EXISTING ELECTRICAL EQUIPMENTS WHICH IS NOT TO BE REUSED SHALL BE REMOVED FROM DRYWALL PARTITIONS. ANY OPENING IN EXISTING PARTITIONS LEFT BY REMOVAL OF EXISTING ELECTRICAL EQUIPMENT SHALL BE PATCHED BY THIS CONTRACTOR WITH MATERIALS TO MATCH EXISTING.
21. FOR PURPOSES OF THE CONTRACT, WHAT IS NOTED OR SHOWN ON DRAWINGS INDICATES THE SCOPE OF WORK REQUIRED AND QUALITY OF MATERIALS REQUIRED.
22. CONTRACTOR TO EXAMINE ALL CONTRACT DOCUMENTS AND PERFORM ALL DEMOLITION BOTH FOR AREAS BEING RENOVATED AND FOR AREAS WHICH MUST BE REWORKED TO PERMIT THE INSTALLATION OF WORK BY THE VARIOUS TRADES.
23. CONTRACTOR SHALL VISIT THE SITE AND VERIFY THE EXTENT OF DEMOLITION AND REMOVALS PRIOR TO THE SUBMISSION OF BIDS. NO CONSIDERATION SHALL BE GIVEN FOR FAILURE TO VISIT THE SITE.
24. CONTRACTOR SHALL UTILIZE ALL THE BREAKERS IN THE EXISTING PANELS THAT BECOME AVAILABLE WHEN BRANCH CIRCUITS ASSOCIATED WITH THEM ARE DISCONNECTED AND REMOVED DUE TO DEMOLITION OF THE ELECTRICAL WORK.

ELECTRICAL LEGEND

(NOT ALL SYMBOLS ARE USED)

- DISTRIBUTION PANEL, 480/277 VOLT
- ELECTRICAL PANEL, 480/277 VOLT
- ELECTRICAL PANEL, 120/208 VOLT
- PANELBOARD FLUSH MOUNTED
- PANELBOARD SURFACE MOUNTED
- NON-FUSED DISCONNECT SWITCH
- FUSED DISCONNECT SWITCH
- J — WALL MOUNTED JUNCTION BOX, ACCORDING TO NEC REQUIREMENTS
- J — CEILING MOUNTED JUNCTION BOX, ACCORDING TO NEC REQUIREMENTS
- MOTOR STARTER, COORDINATE EXACT REQUIREMENTS WITH MOTOR FURNISHED
- DUPLEX RECEPTACLE; MOUNT AT 18" AFF UNLESS OTHERWISE SPECIFIED
- SINGLE RECEPTACLE; MOUNT AT 18" AFF UNLESS OTHERWISE SPECIFIED
- QUAD RECEPTACLE; MOUNT AT 18" AFF UNLESS OTHERWISE SPECIFIED
- GFI — GROUND FAULT INTERRUPTING DUPLEX RECEPTACLE; MOUNT AT 18" AFF UNLESS OTHERWISE SPECIFIED
- WP — RECEPTACLE WITH OUTDOOR RATED COVER PLATE. PROVIDE FLUSH MOUNTED BOX
- SPECIAL OUTLET CONFIGURATION, SEE NEMA #
- CEILING MOUNTED DUPLEX RECEPTACLE; PROVIDE FLUSH MOUNTED BOX
- FLOOR MOUNTED RECEPTACLE; SEE SPECIFICATION FOR DETAILS
- OXT — BRANCH CIRCUIT HOMERUN (VOLTAGE, BRANCH CIRCUIT POLES)
- TYPICAL RECESSED/SURFACE MOUNTED LIGHT FIXTURE; LETTER INDICATES FIXTURE TYPE
- CEILING/WALL MOUNTED EXIT SIGN, SHADING INDICATES DIRECTION OF FACE, ARROW INDICATES DIRECTION OF CHEVRON
- DOUBLE FACE EXIT SIGN
- CEILING MOUNTED "CALL-FOR-AID" LIGHT/BUZZER
- FIRE ALARM SMOKE DETECTOR
- S — ROUND RECESSED CEILING SPEAKER (PAGING)
- DUAL HEADED CEILING MOUNTED SECURITY CAMERA

ABBREVIATIONS

A	AMPERES
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
ATS	AUTOMATIC TRANSFER SWITCH
C	CONDUIT
CB	CIRCUIT BREAKER
CFW	COLD FOOD WELL
CKT	CIRCUIT
COF	COFFEE MAKER
CR	CASH REGISTER
DIA	DIAMETER
DW	DISH WASHER
EC	ELECTRICAL CONTRACTOR
EWC	ELECTRIC WATER COOLER
EWH	ELECTRIC WATER HEATER
EX	EXISTING TO REMAIN
REM	EXISTING TO BE REMOVED
HFW	HOT FOOD WELL
HT	HEAT TRACE
JB	JUNCTION BOX
MB	MAIN BREAKER
MIC	MICROWAVE OVEN
MLO	MAIN LUG ONLY
MTD	MOUNTED
OHD	OVER HEAD DOOR
PNL	PANELBOARD
RELOC	RELOCATE/RELOCATED AT THE SAME HEIGHT (PER NEC REQUIREMENTS)
REF	REFRIGERATOR
SG	SNEEZE GUARD
UCR	UNDER COUNTER REFRIGERATOR
U.O.N.	UNLESS OTHERWISE NOTED
WP	WEATHERPROOF

GENERAL NOTES

GENERAL

1. WHEN A CONFLICT BETWEEN THE DRAWINGS, NOTES AND/OR SPECIFICATIONS OCCUR, THE MORE STRINGENT, AND/OR LARGER QUANTITY AND/OR MORE EXPENSIVE SHALL APPLY. THE REQUIREMENTS LISTED WITHIN NOTES OR SPECIFICATIONS SHALL BE REQUIRED, PROVIDED AND INSTALLED WHETHER SPECIFICALLY INDICATED ON THE DRAWINGS OR NOT.

WIRING & RACEWAY:

1. THE DRAWINGS SHOW THE GENERAL LAYOUT AND TYPICAL DETAILS. PROVIDE COMPLETE SYSTEMS. DRAWINGS ARE BASED ON THE SPECIFIED EQUIPMENT. RACEWAY LAYOUTS, BOXES, AND WIRING OF THE SYSTEMS ARE SUBJECT TO APPROVED SHOP DRAWINGS.
2. ENSURE THAT ITEMS TO BE FURNISHED FIT THE SPACE AVAILABLE. MAKE NECESSARY FIELD MEASUREMENTS TO ASCERTAIN SPACE REQUIREMENTS, INCLUDING THOSE FOR CONNECTIONS, AND PROVIDE SUCH SIZES AND SHAPES OF EQUIPMENT THAT FINAL INSTALLATION SHALL SATISFY THE INTENT OF THE DRAWINGS AND SPECIFICATIONS.
3. LOCATIONS OF OUTLETS, SWITCHES, APPLIANCES, ETC. AS SHOWN ON ELECTRICAL PLANS ARE APPROXIMATE; COORDINATE WITH ARCHITECTURAL AND MECHANICAL PLANS AND DETAILS, AND WITH JOB CONDITIONS. INSTALL SWITCHES WITH "OFF" POSITION DOWN. INSTALL RECEPTACLES WITH GROUNDING POLE IN THE UP POSITION FOR VERTICAL MOUNTING AND AT RIGHT FOR HORIZONTAL MOUNTING.
4. LOCATE AND INSTALL ELECTRICAL EQUIPMENT, JUNCTION AND PULL BOXES, PANELBOARDS, SWITCHES, CONTROLS, AND OTHER APPARATUS REQUIRING MAINTENANCE, INSPECTION, AND OPERATION SO AS TO BE READILY ACCESSIBLE.

RACEWAY INSTALLATION:

1. IN ALL ARCHITECTURALLY FINISHED SPACES, CONDUITS AND CABLES SHALL BE RUN CONCEALED IN HUNG OR FURRED CEILINGS, SLABS, MASONRY, AND PARTITIONS UNLESS OTHERWISE INDICATED. SAW CUTTING AND FINISHED PATCHING SHALL BE REQUIRED IN EXISTING SLABS AND MASONRY WALLS. IN UNFINISHED SPACES, RACEWAYS MAY BE RUN EXPOSED.
2. UNLESS OTHERWISE INDICATED, EXACT ROUTING OF RACEWAYS SHALL BE DETERMINED BY THE CONTRACTOR TO SUIT PROJECT REQUIREMENTS AND FIELD CONDITIONS.
3. PROVIDE SEPARATE RACEWAYS, JUNCTION BOXES, PULL BOXES AND WIREWAYS FOR ALL EMERGENCY SYSTEM WIRING.

WIRING INSTALLATION:

1. DO NOT USE WIRE SMALLER THAN NO. 12 AWG FOR ANY POWER OR LIGHTING CIRCUIT. USE LARGER SIZES WHERE INDICATED, AS REQUIRED BY CODES, AND AS FOLLOWS:

   30 AMPERE CIRCUIT: NO. 10
   40 AMPERE CIRCUIT: NO. 8
   50 AMPERE CIRCUIT: NO. 6
   60 AMPERE CIRCUIT: NO. 6

A. MINIMUM HOMERUN AND BRANCH CIRCUIT WIRING SIZES AND MAXIMUM HOMERUN CONDUIT FILL FOR 120 VOLT, 20 AMPERE CIRCUITS SHALL BE AS FOLLOWS:

LENGTH	CIRCUIT WIRE SIZE	HOME RUN WIRE SIZE	CONDUIT SIZE (8 WIRES/CONDUIT)
0' TO 50'	#12	#12	3/4"
51' TO 100'	#12	#10	3/4"
101' TO 200'	#10	#8	1"

GREATER THAN 200' - REQUEST DIRECTION FROM ARCHITECT.

NOTE: PROVIDE DERATING PER CODE WHEN INSTALLING MORE THAN 3 CURRENT CARRYING CONDUCTORS IN CONDUIT.

B. HOME RUNS AND BRANCH CIRCUIT WIRING FOR 277 VOLT, 20 AMPERE CIRCUITS SHALL BE AS FOLLOWS:

LENGTH	CIRCUIT WIRE SIZE	HOME RUN WIRE SIZE	CONDUIT SIZE (8 WIRES/CONDUIT)
0' TO 100'	#12	#12	3/4"
100' TO 200'	#12	#10	3/4"

GREATER THAN 200' - REQUEST DIRECTION FROM ARCHITECT.

NOTE: PROVIDE DERATING PER CODE WHEN INSTALLING MORE THAN 3 CURRENT CARRYING CONDUCTORS IN CONDUIT.

2. DO NOT USE WIRE SMALLER THAN NO. 14 AWG FOR CONTROL CIRCUITS UNLESS OTHERWISE RECOMMENDED BY THE EQUIPMENT OR SYSTEM MANUFACTURER ON WIRING SHOP DRAWINGS, AND SO APPROVED BY THE ARCHITECT.
3. WHERE GREATER THAN THREE (3) CURRENT-CARRYING CONDUCTORS ARE INSTALLED IN ANY ONE CONDUIT OR CABLE, CONDUCTORS MUST BE DERATED AND SIZES INCREASED, IF NEEDED, TO ACCOMMODATE CONDUCTOR DERATING AS REQUIRED BY NEC ARTICLE 310.
4. CONDUCTORS SHALL BE COMPLETELY INSTALLED AND CONNECTED. PROVIDE ALL TERMINALS, LUGS, AND CONNECTORS TO SUIT THE APPLICATION, AND IN COMPLIANCE WITH EQUIPMENT MANUFACTURERS' RECOMMENDATIONS.
5. UNDER NO CIRCUMSTANCES SHALL ANY SWITCH OR CIRCUIT BREAKER BREAK A NEUTRAL CONDUCTOR.
6. THE CIRCUIT NUMBERS INDICATED ON THE DRAWINGS ARE INTENDED AS A GUIDE FOR PROPER CONNECTION OF CIRCUITS AT PANELS. HOWEVER, IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO ENSURE THAT THE FINAL CIRCUITING WORK FULFILLS THE FOLLOWING CONDITIONS:

A. LOADS ON PANEL BUSSES SHALL BE PHASE-BALANCED AS EVENLY AS POSSIBLE.

GROUNDING INSTALLATION:

1. EQUIPMENT GROUNDING

A. INSTALL AN INSULATED GROUND CONDUCTOR, RUN IN THE RACEWAY WITH THE PHASE CONDUCTORS, FOR EACH FEEDER SERVING: PANELBOARDS, LIGHTING DIMMER BOARDS, MOTOR CONTROL CENTERS, MOTORS, EQUIPMENT AND APPLIANCES UNLESS OTHERWISE NOTED.

B. INCLUDE AN INSULATED GROUND CONDUCTOR IN ALL CONDUIT RUNS CONTAINING SECTIONS OF FLEXIBLE CONDUIT UNLESS OTHERWISE NOTED.

C. INCLUDE AN INSULATED GROUND CONDUCTOR IN ALL BRANCH CIRCUIT RACEWAYS OR CABLES UNLESS OTHERWISE NOTED.

MECHANICAL EQUIPMENT WIRING:

1. UNLESS OTHERWISE INDICATED OR SPECIFIED HEREIN, ALL MOTORS, MOTOR STARTERS, MOTOR CONTROLLERS, VARIABLE SPEED/FREQUENCY DRIVES, AND ASSOCIATED CONTROL DEVICES ARE FURNISHED UNDER DIVISION 23 AND INSTALLED UNDER THIS DIVISION. COORDINATE INSTALLATION AND LOCATIONS WITH OTHER DIVISION CONTRACTORS.
2. POWER WIRING FROM THE INDICATED SOURCE TO THE STARTER/CONTROLLER/DRIVE UNIT, AND FROM THE STARTER/CONTROLLER/DRIVE UNIT TO THE MOTOR, INCLUDING ANY LOCAL DISCONNECT SWITCHES PROVIDED AND INSTALLED BY THIS DIVISION, AND ALL ASSOCIATED LUGS, TERMINALS, AND CONNECTIONS, IS THE WORK OF THIS DIVISION.
3. CONTROL CIRCUIT WIRING IS GENERALLY FURNISHED AND INSTALLED UNDER OTHER DIVISIONS, EXCEPT THAT ANY SUCH WIRING SHOWN ON ELECTRICAL DRAWINGS IS WORK OF THIS DIVISION.
4. PROVIDE 120 VOLT POWER TO ALL TEMPERATURE CONTROL PANELS (TCP'S) SUPPLIED AND INSTALLED BY DIVISION 23. USE EMERGENCY POWER SOURCES WHEN AVAILABLE. COORDINATE ALL POWER REQUIREMENTS AND PANEL LOCATIONS WITH DIVISION 23 TEMPERATURE CONTROLS CONTRACTOR.
5. COOPERATE AND COORDINATE WITH THE OTHER TRADES IN THE INSTALLATION, CONNECTION, AND TESTING OF MECHANICAL EQUIPMENT. PERFORM WORK OF THIS SECTION IN ACCORDANCE WITH EQUIPMENT MANUFACTURERS' INSTRUCTIONS.

COORDINATION DRAWINGS:

1. DEVELOP AND SUBMIT COORDINATION DRAWINGS AS OUTLINED.

A. SHEET METAL, PLUMBING AND FIRE PROTECTION SHOP DRAWINGS THAT HAVE BEEN COORDINATED WITH ARCHITECTURAL AND STRUCTURAL DRAWINGS SHALL BE SUBMITTED TO ENGINEER FOR REVIEW. DRAWINGS MUST BE RETURNED FROM ENGINEER EITHER "REVIEWED" OR "FURNISH AS CORRECTED" PRIOR TO BEING USED AS BASIS FOR COORDINATION DRAWINGS.

B. AFTER SHEET METAL AND PIPING DRAWINGS HAVE BEEN REVISED PER ENGINEERS COMMENTS, REPRODUCIBLE COPIES SHALL BE SENT TO THE TRADES IN THE FOLLOWING SEQUENCE FOR THE INCLUSION OF THEIR WORK:

   -MECHANICAL SHEET METAL
   -PLUMBING PIPING
   -MECHANICAL PIPING
   -SPRINKLER PIPING
   -ELECTRICAL WORK

2. AFTER ALL TRADES HAVE INCLUDED THEIR WORK ON THE COORDINATION DRAWING AND NOTED CONFLICTS, ALL TRADES SHALL MEET TO RESOLVE CONFLICTS AND AGREE TO ACCEPTABLE SOLUTIONS. EACH TRADE SHALL SIGN COORDINATION DRAWINGS. ITEMS NOT SHOWN ON COORDINATION DRAWING IS RESPONSIBILITY OF OMITTING CONTRACTOR AND CONTRACTOR IS SUBJECT TO ADDITIONAL COSTS INCURRED BY OTHER TRADES.
3. THE ARCHITECT AND ENGINEER ARE NOT PART OF THE COORDINATION DRAWING PROCESS. THE ENGINEER WILL PROVIDE ASSISTANCE FOR NOTED CONFLICTS ONLY. COORDINATION DRAWINGS ARE NOT TO BE CONSIDERED PIPING OR DUCT SHOP DRAWINGS. THE CONTRACTOR IS REQUIRED TO SUBMIT INDIVIDUAL PIPING AND DUCTWORK SHOP DRAWINGS FOR REVIEW BY THE ENGINEER. PIPING AND DUCTWORK SHOP DRAWINGS SHALL FOLLOW THE DESIGN INTENT OF THE CONTRACT DOCUMENTS.
4. SUBMIT FINAL SIGNED COORDINATION DRAWING TO ENGINEER FOR REVIEW. ENGINEER WILL REVIEW COORDINATION DRAWINGS FOR GENERAL ARRANGEMENT AND FOR NOTED CONFLICTS ONLY. SPECIFIC INSTALLATION REQUIREMENTS WILL BE REVIEWED ONLY IN INDIVIDUAL TRADE SHOP DRAWINGS.
5. ANY WORK FABRICATED OR INSTALLED PRIOR TO SIGN OFF BY ALL TRADES WHICH IS DEEMED TO BE IN CONFLICT WITH COORDINATION DRAWINGS SHALL BE REMOVED AND RE-INSTALLED IN CONFORMANCE WITH COORDINATION DRAWINGS.
6. EACH CONTRACTOR (MENTIONED ABOVE) IS RESPONSIBLE FOR THE COORDINATION OF HIS SUB-CONTRACTORS.
7. THE OVERALL COORDINATION OF THE COORDINATION PROCESS IS THE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER IS NOT RESPONSIBLE FOR THE COORDINATION PROCESS. THE ENGINEER WILL RESPOND TO QUESTIONS THAT ARISE FROM THE COORDINATION PROCESS. DRAWINGS SUBMITTED WILL BE REVIEWED FOR CLEARLY IDENTIFIED CONFLICTS ONLY. SOLUTIONS TO CONFLICTS WILL NOT BEAR ADDITIONAL COST.

AS BUILT DRAWINGS

1. PROVIDE A COMPLETE SET OF AS-BUILT DRAWINGS REFLECTING AS INSTALLED CONDITIONS. AS-BUILT DRAWINGS SHALL INDICATE ALL INSTALLED CONDITIONS OF SYSTEMS WITHIN THIS DISCIPLINE. DRAWINGS SHALL BE OF SIMILAR SCALE AS THE CONSTRUCTION DOCUMENTS AND INCLUDE DETAILS AS NECESSARY TO CLEARLY REFLECT THE INSTALLED CONDITION. DRAWINGS SHALL BE BOUND IN A COMPLETE AND CONSECUTIVE SET. SUPPLEMENTAL SKETCHES AND LOOSE PAPERWORK WILL NOT BE ACCEPTABLE AND WILL BE RETURNED FOR REVISION. THE CONTRACTOR SHALL COMPLY WITH THE ENGINEERS COMMENTS TO PRODUCE A CLEAR AND CONCISE SET OF DRAWINGS. DRAWINGS SHALL BE SUBMITTED IN BOTH HARD COPY AND ELECTRONIC (AUTO-CAD VERSION AS REQUIRED BY THE OWNER) VERSION. NUMBER OF COPIES OF EACH AS REQUESTED BY THE OWNER.
2. PROVIDE "AS-BUILT DRAWINGS" INDICATING IN A NEAT AND ACCURATE MANNER A COMPLETE RECORD OF ALL REVISIONS OF THE ORIGINAL DESIGN OF THE WORK. INDICATE THE FOLLOWING INSTALLED CONDITIONS:

A. INCLUDE ALL CHANGES AND AN ACCURATE RECORD, ON REPRODUCTIONS OF THE CONTRACT DRAWINGS OR APPROPRIATE SHOP

B. DRAWINGS, OF ALL DEVIATIONS, BETWEEN THE WORK SHOWN AND WORK INSTALLED.

C. EQUIPMENT LOCATIONS (EXPOSED AND CONCEALED), DIMENSIONED FROM PROMINENT BUILDING LINES.

D. APPROVED SUBSTITUTIONS, CONTRACT MODIFICATIONS, AND ACTUAL EQUIPMENT AND MATERIALS INSTALLED.

E. CONTRACT MODIFICATIONS, ACTUAL EQUIPMENT AND MATERIALS INSTALLED.

F. SUBMIT FOR REVIEW BOUND SETS OF THE REQUIRED DRAWINGS, MANUALS AND OPERATING INSTRUCTIONS.

G. SUBMIT A COMPLETE MAINTENANCE MANUAL OF ALL EQUIPMENT INSTALLED UNDER THIS CONTRACT.

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

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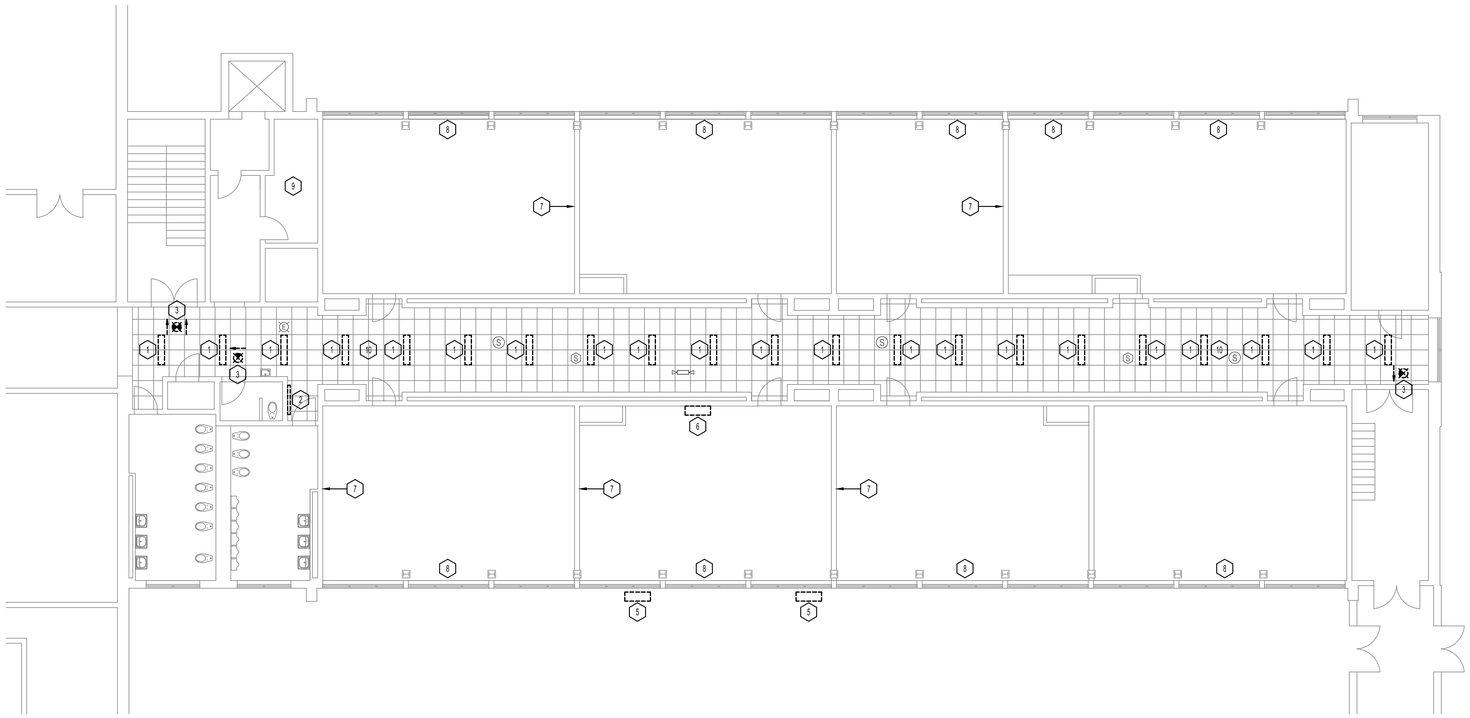
Revision:	Description:	Date:	Revised By:

Drawing Title:
SYMBOLS, NOTES & ABBREVIATIONS

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: PCC
Project Number: 22.335

Drawing Number: E001



1 BUILDING 'B' FIRST FLOOR DEMOLITION PLAN

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

NORTH

GENERAL DEMOLITION NOTES

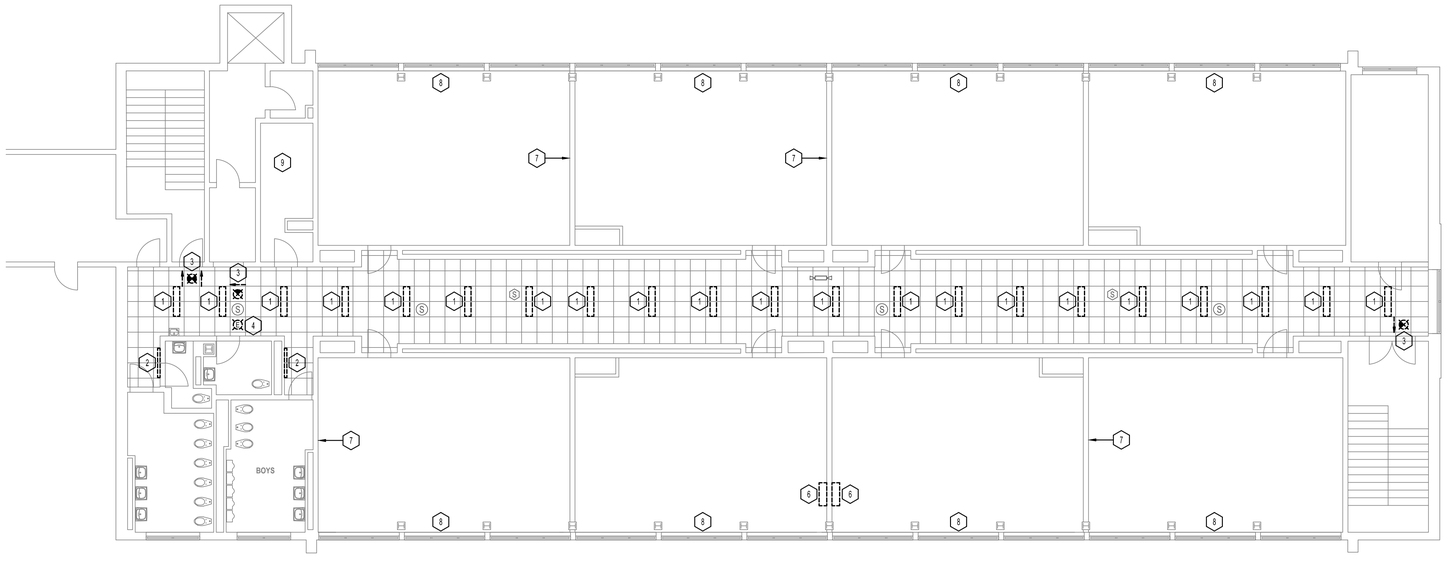
1. ALL LIGHT FIXTURES, EXIT SIGNS, EMERGENCY LIGHTS, SECURITY CAMERAS, SPEAKERS, CALL FOR AID LIGHT, ETC. SHOWN DARK AND DASHED OR SOLID ARE TO BE REMOVED UNLESS OTHERWISE NOTED. ALL LIGHT FIXTURES, EXIT SIGNS, ETC. SHOWN HALF TONED (LIGHT) AND SOLID ARE EXISTING TO REMAIN UNLESS OTHERWISE NOTED.
2. ALL EXISTING CEILING MOUNTED FIXTURES/DEVICES TO REMAIN SHALL BE REMOVED, STORED AND PROTECTED DURING THE EXTENT OF THE RENOVATION AND THEN REINSTALLED IN THE LOCATION IN THE NEW CEILING.

DEMOLITION KEY NOTES

1. DISCONNECT AND REMOVE EXISTING SURFACE MOUNTED 1X4 LENSED FLUORESCENT LIGHT FIXTURE AND ALL ASSOCIATED MOUNTING HARDWARE. EXISTING BRANCH CIRCUIT SHALL BE MADE SAFE TO SERVE NEW LIGHT FIXTURES IN THIS LOCATION.
2. DISCONNECT AND REMOVE EXISTING SURFACE/WALL MOUNTED 4 FT. LENSED FLUORESCENT LIGHT FIXTURE AND ALL ASSOCIATED MOUNTING HARDWARE. EXISTING BRANCH CIRCUIT SHALL BE MADE SAFE TO SERVE NEW LIGHT FIXTURES IN THIS LOCATION.
3. DISCONNECT AND REMOVE EXISTING CEILING MOUNTED EXIT SIGN AND ALL ASSOCIATED MOUNTING HARDWARE. EXISTING BRANCH CIRCUIT SHALL BE MADE SAFE TO SERVE NEW EXIT SIGN IN THIS LOCATION.
4. DISCONNECT AND REMOVE EXISTING CEILING MOUNTED "CALL-FOR-AID" DOME LIGHT AND BUZZER. EXISTING BRANCH CIRCUIT SHALL BE MADE SAFE TO SERVE NEW UNIT IN THIS LOCATION.
5. DISCONNECT AND REMOVE ELECTRICAL CONNECTION TO EXISTING SPLIT SYSTEM OUTDOOR UNIT TO BE REMOVED, INCLUDING BUT NOT LIMITED TO, DISCONNECT SWITCH AND ALL CONDUIT AND WIRING BACK TO POINT OF ORIGIN.
6. DISCONNECT AND REMOVE ELECTRICAL CONNECTION TO EXISTING SPLIT SYSTEM INDOOR UNIT TO BE REMOVED, INCLUDING BUT NOT LIMITED TO, DISCONNECT SWITCH AND ALL CONDUIT AND WIRING BACK TO POINT OF ORIGIN.
7. DISCONNECT, REMOVE AND RELOCATE EXISTING SURFACE MOUNTED RACEWAY(S) [WIREMOLD] AND ALL ASSOCIATED WIRING ON THIS WALL TO AVOID NEW MECHANICAL UNIT. COORDINATE WITH MECHANICAL CONTRACTOR LOCATION OF NEW MECHANICAL UNIT ON THIS WALL IN ORDER TO KNOW WHERE TO REROUTE EXISTING RACEWAY.
8. DISCONNECT AND REMOVE EXISTING ELECTRICAL CONNECTION TO UNIT VENTILATOR TO BE ABANDONED IN PLACE. REMOVE WIRING FROM UNIT TO ABOVE CEILING AND MAKE SAFE. ALSO REMOVE WIRING FROM BREAKER IN PANEL SERVING UNIT(S) AND MAKE SAFE AND LABEL WIRING ACCORDINGLY. UPDATE DIRECTORY TO INDICATE BREAKER AS SPARE.
9. DISCONNECT AND REMOVAL EXISTING ELECTRICAL CONNECTION TO CEILING MOUNTED CABINET UNIT HEATER TO BE REMOVED IN THIS LOCATION. REMOVE WIRING BACK TO NEAREST ACCESSIBLE JUNCTION BOX AND MAKE SAFE AND LABEL WIRING ACCORDINGLY.
10. DISCONNECT, REMOVE AND RELOCATE EXISTING CONDUIT & WIRE ALONG WITH MC CABLE AND LOW VOLTAGE WIRING ABOVE THE CEILING IN THE CORRIDOR TO ACCOMMODATE NEW DUCTWORK AND PIPING. COORDINATE WITH MECHANICAL CONTRACTOR EXACT LOCATIONS WHERE CONDUIT AND WIRE NEEDS TO BE RELOCATED.

ALTERNATE

CONTRACTOR SHALL DISCONNECT, REMOVE AND STORE ALL EXISTING SURFACE MOUNTED 1X4 LIGHT FIXTURES. CEILING/WALL MOUNTED 4 FT. LIGHT FIXTURES AND EXIT SIGNS TO BE REUSED/REINSTALLED. CONTRACTOR SHALL STORE AND PROTECT ALL OF THE FIXTURES THROUGHOUT THE ENTIRE RENOVATION. THEN, PRIOR TO REINSTALLING CLEAN AND RE-LAMP ALL FIXTURES AND CARRY FIVE NEW BALLASTS IN CASE SOME DO NOT WORK AT TIME OF REINSTALLATION.



2 BUILDING 'B' SECOND FLOOR DEMOLITION PLAN

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

NORTH

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES

3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

Drawing Title:

BUILDING "B" FIRST & SECOND FLOOR DEMOLITION PLANS

State Project #144-_ _ _ _ _ _

Date: 2-09-2024

Scale: AS NOTED

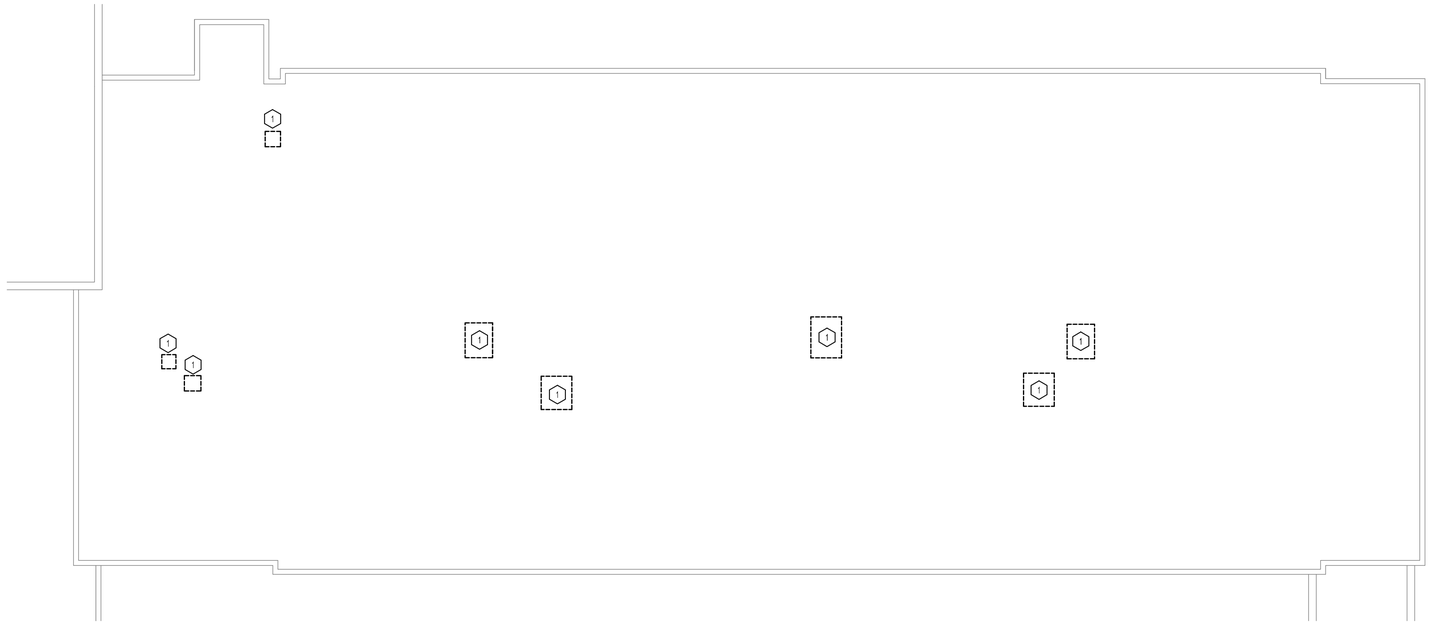
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Project Number: 22.335

Drawing Number: E010

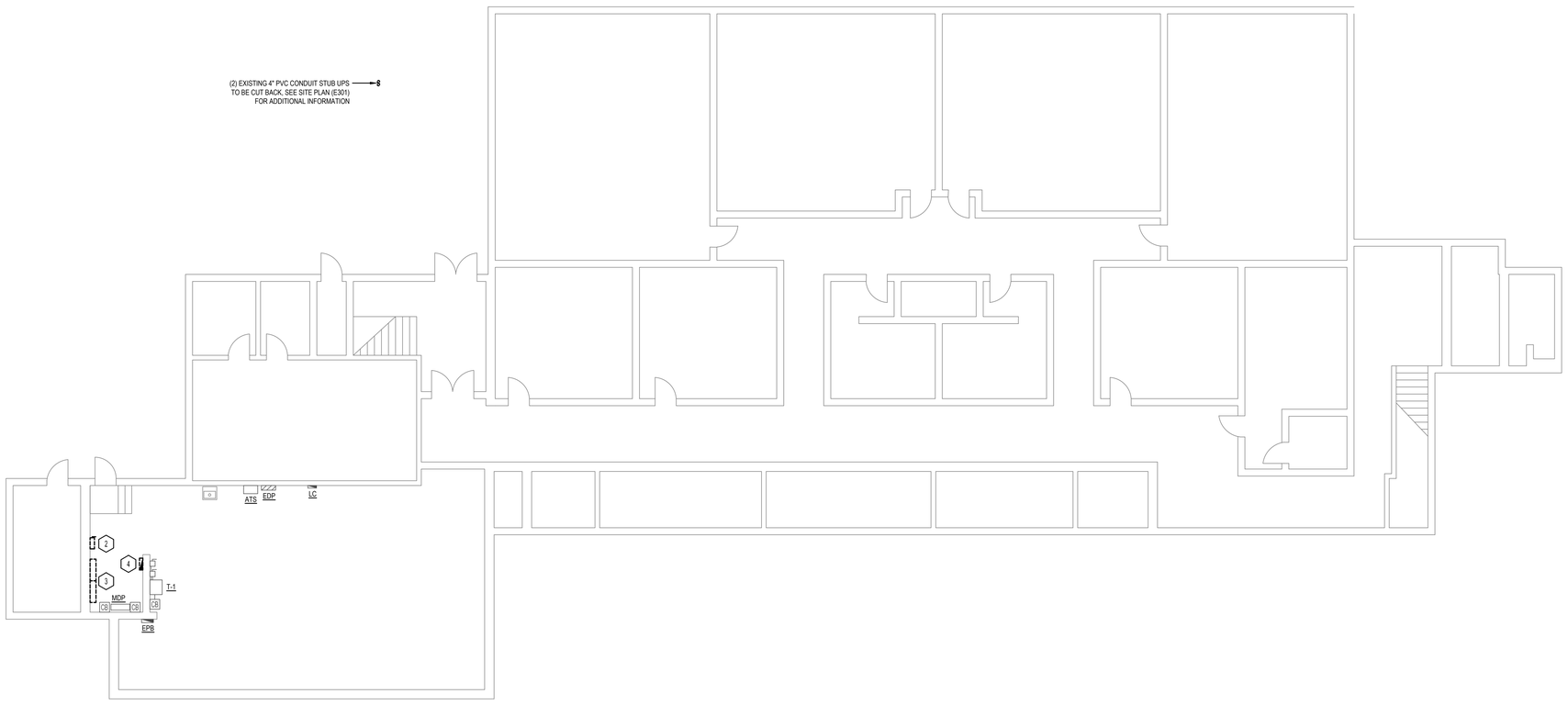
DEMOLITION KEY NOTES

1. DISCONNECT AND REMOVE EXISTING ELECTRICAL CONNECTION TO EXISTING EXHAUST FAN TO BE REMOVED IN THIS LOCATION, INCLUDING BUT NOT LIMITED TO DISCONNECT SWITCH, JUNCTION BOX, CONDUIT & WIRING (BRANCH CIRCUIT) BACK TO POINT OF ORIGIN.
2. DISCONNECT AND REMOVE EXISTING SURFACE MOUNTED 400 AMP DISCONNECT SWITCH (PREVIOUSLY SERVED PORTABLE CLASSROOMS), INCLUDING BUT NOT LIMITED DISCONNECT AND ALL ACCESSIBLE CONDUIT AND ALL WIRING COMPLETELY. CONDUIT RECESSED IN WALLS AND IN SLAB/UNDERGROUND SHALL REMAIN.
3. DISCONNECT AND REMOVE EXISTING "ORIGINAL" MAIN DISTRIBUTION PANEL (I-SECTION). ALL ACTIVE BRANCH CIRCUITS SHALL REMAIN AND BE MADE SAFE TO BE RECONNECTED TO NEW DISTRIBUTION IN THIS LOCATION. EXISTING BRANCH CIRCUIT CURRENTLY SERVING THE FIRE ALARM SYSTEM (15A-2P) SHALL BE RELOCATED TO THE EXISTING GENERATOR PANEL 'EDP'. REFER TO POWER PLAN AND ONE LINE DRAWING (E111 & E401) FOR MORE INFORMATION.
4. DISCONNECT AND REMOVE EXISTING PANEL (BOILER ROOM). ALL ACTIVE BRANCH CIRCUITS SHALL BE RELOCATED/ EXTENDED TO NEW DISTRIBUTION PANEL 'DP-L'. REFER TO POWER PLAN AND ONE LINE DRAWING (E111 & E401) FOR MORE INFORMATION.



1 BUILDING 'B' ROOF DEMOLITION PLAN
SCALE: 1/8" = 1'-0"

NORTH



2 BUILDING 'B' BASEMENT FLOOR DEMOLITION PLAN
SCALE: 1/8" = 1'-0"

NORTH

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES
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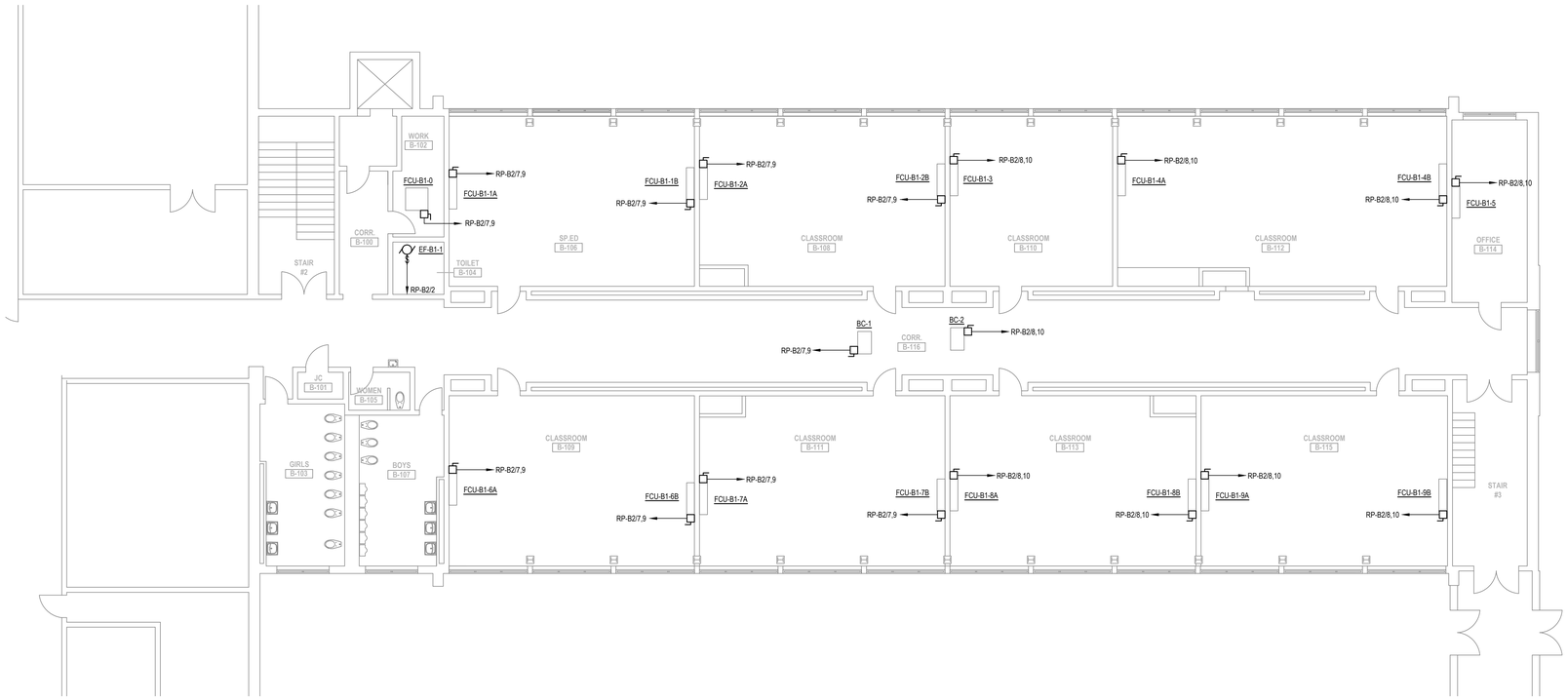
Revision:	Description:	Date:	Revised By:

Drawing Title:
BUILDING "B" ROOF & BASEMENT FLOOR DEMOLITION PLANS

State Project #144-_ _ _ _ _ _

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Project Number: 22.335

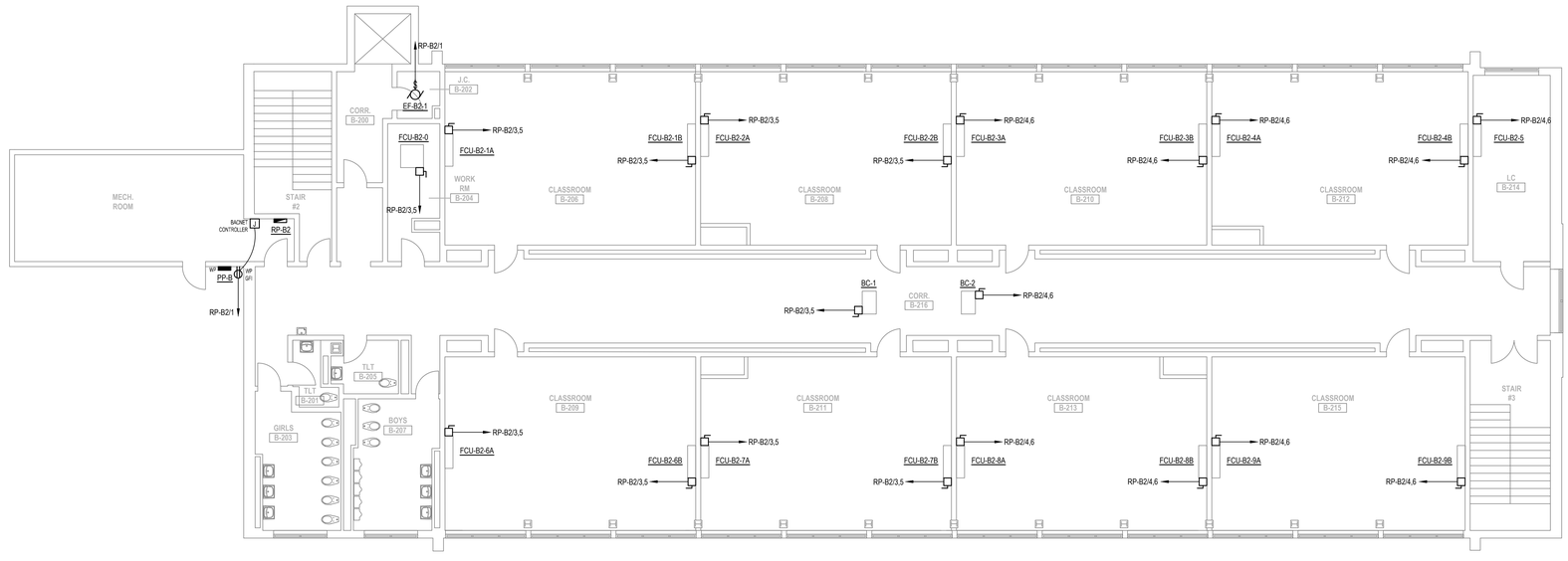
Drawing Number: E011



1 BUILDING 'B' FIRST FLOOR PLAN

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

NORTH



2 BUILDING 'B' SECOND FLOOR PLAN

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

NORTH

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

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Drawing Title:

BUILDING "B" FIRST & SECOND FLOOR POWER PLANS

State Project #144-_ _ _ _ _ _

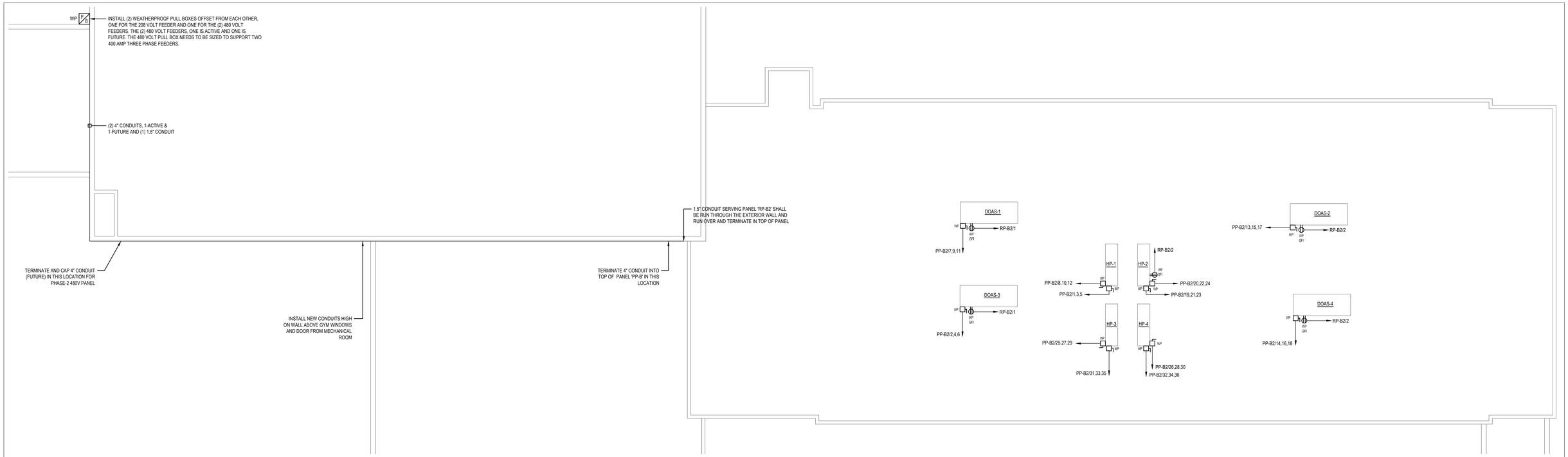
Date: 2-09-2024

Scale: AS NOTED

Drawn By: SEC / PCC

Project Number: 22.335

Drawing Number: E110



1 BUILDING 'B' ROOF PLAN

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

NORTH



2 BUILDING 'B' BASEMENT FLOOR PLAN

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

NORTH

GENERAL NOTES

1. REFER TO DRAWING E001 FOR ELECTRICAL SYMBOLS AND ABBREVIATIONS.
2. CONTRACTOR SHALL FURNISH AND INSTALL A SIGN MOUNTED ON OR ADJACENT TO SERVICE ENTRANCE MAIN DISCONNECT SWITCH, INDICATING THERE IS AN EMERGENCY POWER SOURCE (GENERATOR) AND ITS LOCATION PER NEC 700.7.
3. CONTRACTOR SHALL RECONNECT/EXTEND ALL EXISTING ACTIVE BRANCH CIRCUITS MADE SAFE DURING THE DEMOLITION PHASE OF THE PROJECT IN THIS LOCATION TO NEW MATCHING CIRCUIT BREAKERS IN NEW DISTRIBUTION PANEL "MDP-2". EXISTING BRANCH CIRCUIT MADE SAFE THAT SERVES THE FIRE ALARM SYSTEM (20A-P) SHALL BE MOVED/RELOCATED TO NEW MATCHING CIRCUIT BREAKER IN GENERATOR PANEL "EDP".
4. CONTRACTOR SHALL RELOCATE/EXTEND ALL EXISTING ACTIVE BRANCH CIRCUITS MADE SAFE FROM PANEL REMOVED DURING THE DEMOLITION PHASE OF THE PROJECT IN THIS LOCATION TO NEW MATCHING CIRCUIT BREAKERS IN NEW DISTRIBUTION PANEL "DP-L".

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
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Drawing Title:

BUILDING "B" ROOF & BASEMENT FLOOR POWER PLANS

State Project #144-_ _ _ _ _ _

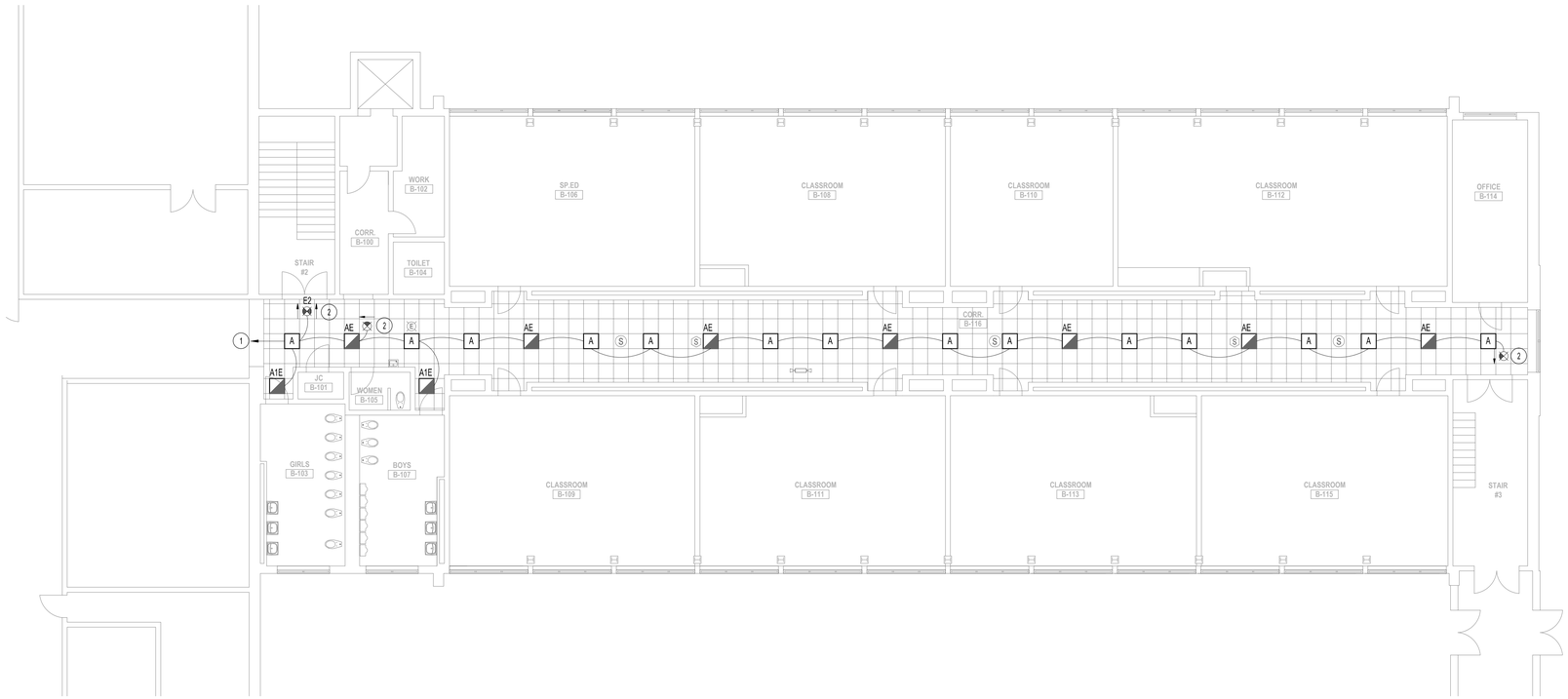
Date: 2-09-2024

Scale: AS NOTED

Drawn By: SEC / PCC

Project Number: 22.335

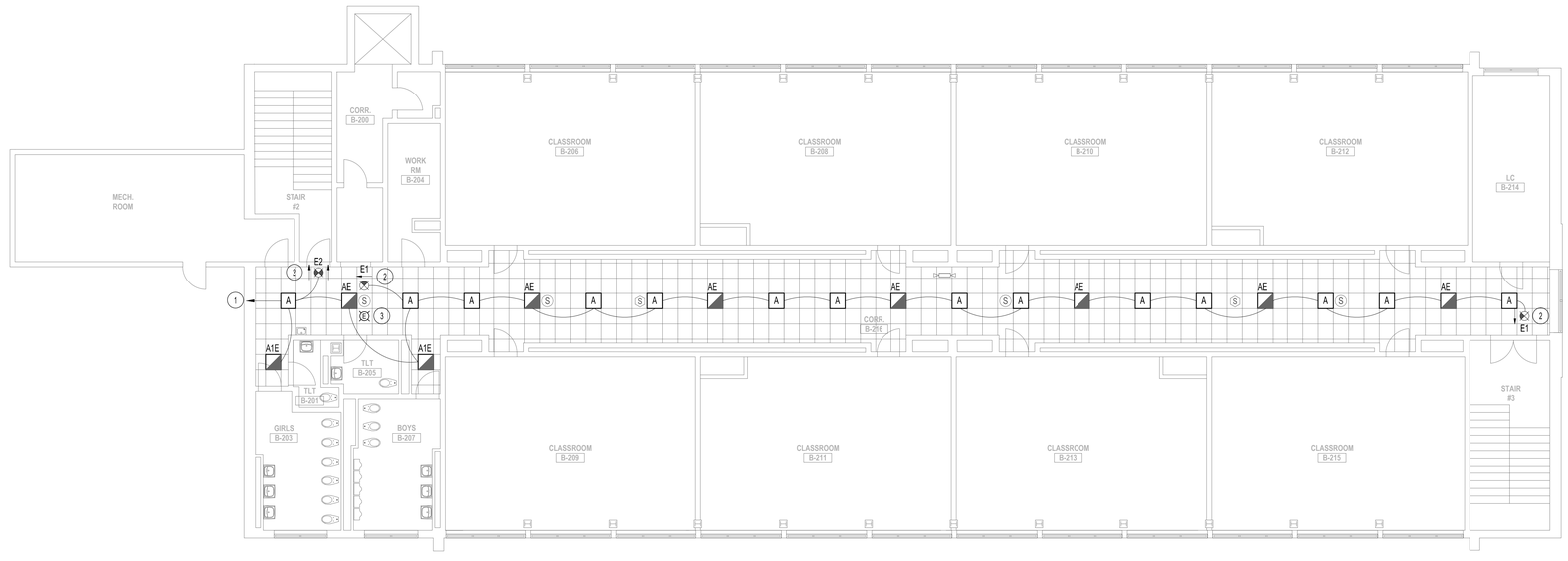
Drawing Number: E111



1 BUILDING 'B' FIRST FLOOR PLAN

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

NORTH



2 BUILDING 'B' SECOND FLOOR PLAN

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

NORTH

GENERAL NOTES

1. ALL EXISTING DEVICES TO REMAIN SHOWN HALF TONED (LIGHT) AND SOLID SHALL BE REINSTALLED IN THE SAME GENERAL LOCATION AS PREVIOUSLY INSTALLED. ADJUST LOCATION INDICATED BASED ON EXISTING WIRING TO BE RECONNECTED.
2. REFER TO DRAWING E001 FOR ELECTRICAL SYMBOLS AND ABBREVIATIONS.

LIGHTING PLAN KEY NOTES

(1) CONTRACTOR SHALL CONNECT NEW LIGHT FIXTURES AND EXIT SIGNS TO THE EXISTING BRANCH CIRCUIT THAT PREVIOUSLY SERVED THIS AREA AND WAS MADE SAFE DURING THE DEMOLITION PHASE.. ALL NEW CONDUIT & WIRING REQUIRED SHALL MATCHBE COMPATIBLE WITH EXISTING WIRING.

(2) CONTRACTOR SHALL CONFIRM IF THE EXISTING EXIT SIGNS WERE WIRED WITH THE EXISTING CORRIDOR LIGHT FIXTURES OR A SEPARATE BRANCH CIRCUIT. IF WIRED TO A SEPARATE BRANCH CIRCUIT THE NEW SIGNS SHALL BE WIRED TO THE SEPARATE BRANCH CIRCUIT NOT WITH THE LIGHT FIXTURES AS INDICATED.

(3) CONTRACTOR SHALL WIRE NEW "CALL-FOR-AID" DOME LIGHT AND BUZZER TO EXISTING BRANCH CIRCUIT THAT PREVIOUSLY SERVED THE UNIT IN THIS LOCATION. NEW LIGHT SHALL BE CONNECTED TO EXISTING CALL CORD TO REMAIN IN TOILET B-205.

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

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Drawing Title:

BUILDING "B" FIRST & SECOND FLOOR LIGHTING PLANS

State Project #144-_ _ _ _ _ _

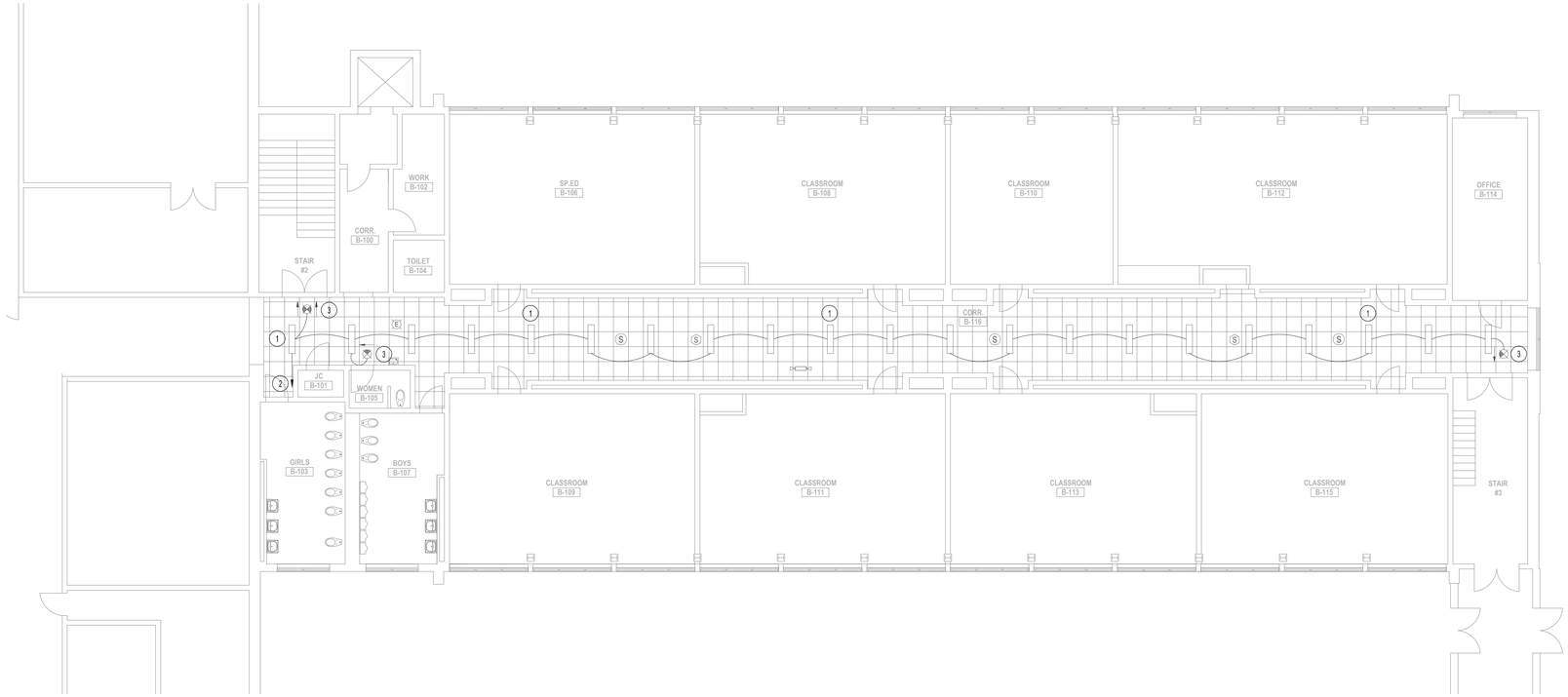
Date: 2-09-2024

Scale: AS NOTED

Drawn By: SEC / PCC

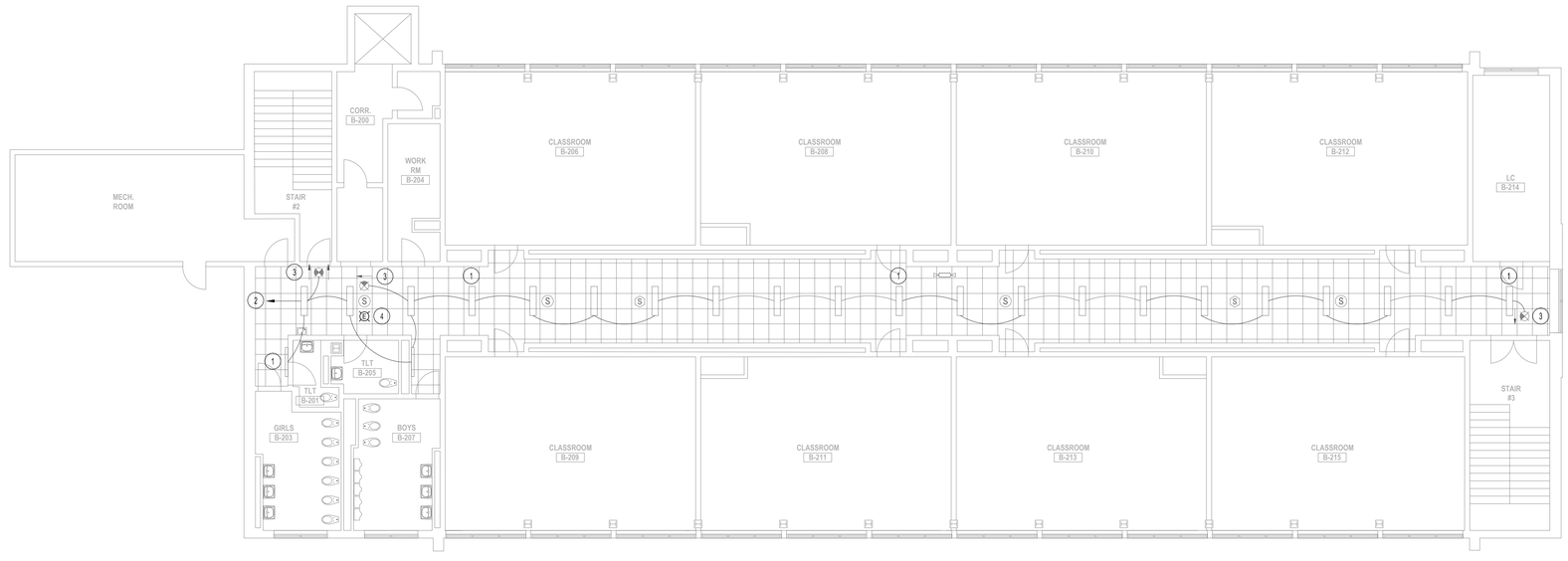
Project Number: 22.335

Drawing Number: E210



1 BUILDING 'B' FIRST FLOOR PLAN

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



2 BUILDING 'B' SECOND FLOOR PLAN

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

GENERAL NOTES

1. ALL EXISTING DEVICES TO REMAIN SHOWN HALF TONED (LIGHT) AND SOLID SHALL BE REINSTALLED IN THE SAME GENERAL LOCATION AS PREVIOUSLY INSTALLED. ADJUST LOCATION INDICATED BASED ON EXISTING WIRING TO BE RECONNECTED.
2. REFER TO DRAWING E001 FOR ELECTRICAL SYMBOLS AND ABBREVIATIONS.

LIGHTING PLAN KEY NOTES

1. CONTRACTOR SHALL REINSTALL EXISTING SURFACE MOUNTED 1X4 FIXTURES, CEILING/WALL MOUNTED 4 FT. FIXTURES AND EXIT SIGNS IN THE SAME LOCATION THEY WERE INSTALLED PREVIOUSLY ON THE NEW CEILING. ALL FIXTURES AND EXIT SIGNS SHALL BE CLEANED AND RE-LAMPED PRIOR BEING REINSTALLED.
2. CONTRACTOR SHALL CONNECT EXISTING LIGHT FIXTURES AND EXIT SIGNS TO THE EXISTING BRANCH CIRCUIT THAT PREVIOUSLY SERVED THIS AREA AND WAS MADE SAFE DURING THE DEMOLITION PHASE. ALL NEW CONDUIT & WIRING REQUIRED SHALL MATCHBE COMPATIBLE WITH EXISTING WIRING.
3. CONTRACTOR SHALL CONFIRM IF THE EXISTING EXIT SIGNS WERE WIRED WITH THE EXISTING CORRIDOR LIGHT FIXTURES OR A SEPARATE BRANCH CIRCUIT. IF WIRED TO A SEPARATE BRANCH CIRCUIT THE NEW SIGNS SHALL BE WIRED TO THE SEPARATE BRANCH CIRCUIT NOT WITH THE LIGHT FIXTURES AS INDICATED.
4. CONTRACTOR SHALL WIRE NEW "CALL-FOR-AID" DOME LIGHT AND BUZZER TO EXISTING BRANCH CIRCUIT THAT PREVIOUSLY SERVED THE UNIT IN THIS LOCATION. NEW LIGHT SHALL BE CONNECTED TO EXISTING CALL CORD TO REMAIN IN TOILET B-205.

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

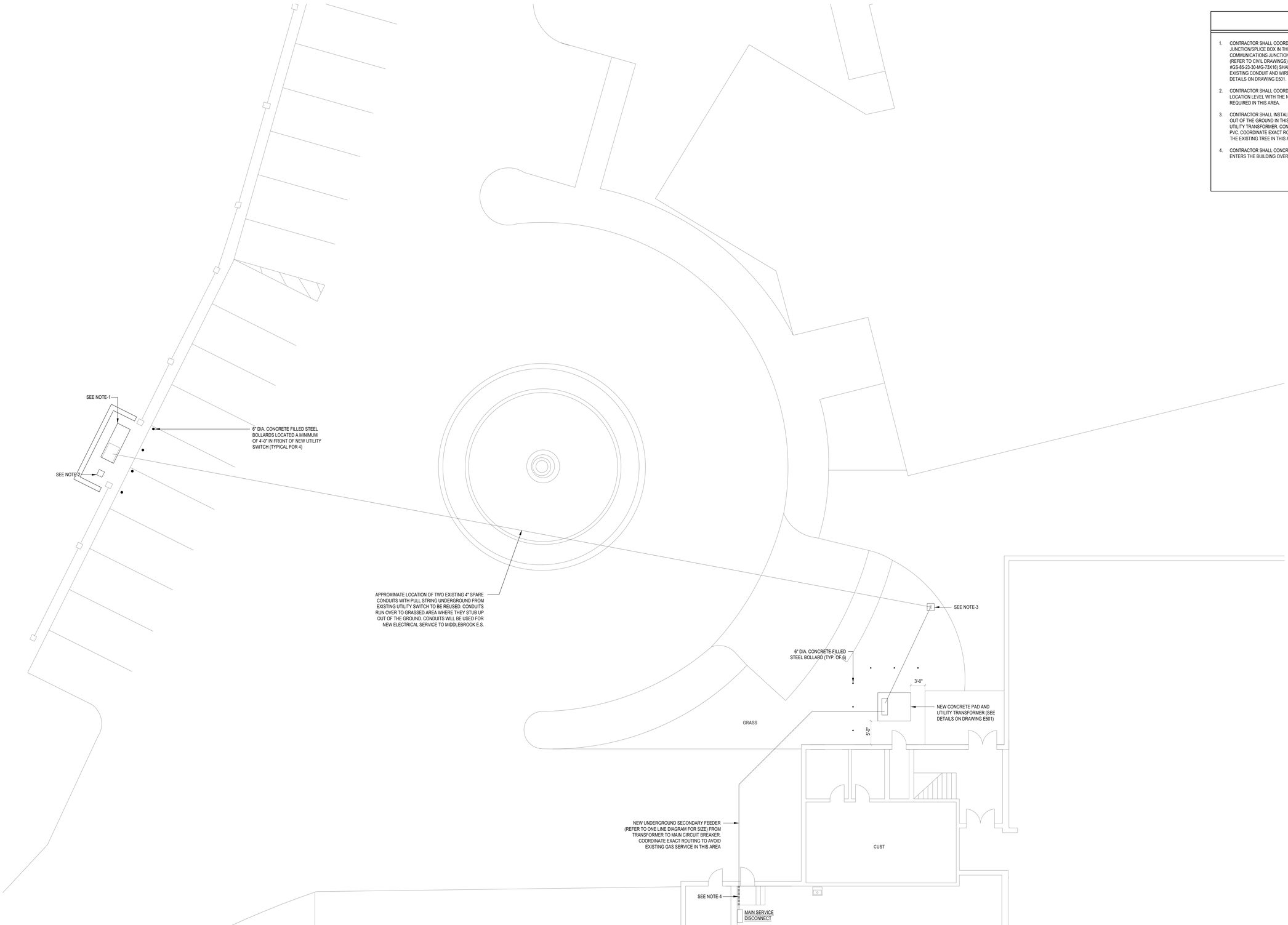
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Drawing Title:
BUILDING "B" FIRST & SECOND FLOOR "ALTERNATE" LIGHTING PLANS
State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: SEC / PCC
Project Number: 22.335

Drawing Number: E210A



1 SITE PLAN

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

NORTH

GENERAL NOTES

1. CONTRACTOR SHALL COORDINATE WITH UNITED ILLUMINATING (U.I.) TO REMOVE THE EXISTING JUNCTION/SPLICE BOX IN THIS LOCATION. SO THE GRADE AROUND THIS BOX AND THE ADJACENT COMMUNICATIONS JUNCTION BOX CAN BE RAISED UP LEVEL WITH THE ADJACENT PARKING LOT (REFER TO CIVIL DRAWINGS). A NEW LARGER JUNCTION BOX AND BASE (NORDIC FIBERGLASS, INC. #GS-85-23-30-MG-73X16) SHALL BE INSTALLED IN THE SAME GENERAL LOCATION AS THE PREVIOUS. EXISTING CONDUIT AND WIRE SHALL BE EXTENDED UP INTO THE BASE OF THE SWITCH. REFER TO DETAILS ON DRAWING ES01.
2. CONTRACTOR SHALL COORDINATE WITH X TO RAISE UP THE EXISTING JUNCTION BOX IN THIS LOCATION LEVEL WITH THE NEW GRADE. REFER TO CIVIL DRAWINGS FOR EXTENT OF SITE WORK REQUIRED IN THIS AREA.
3. CONTRACTOR SHALL INSTALL A NEW PULL BOX OVER THE (2) EXISTING 4" PVC CONDUITS STUBBING OUT OF THE GROUND IN THIS AREA SO THEY CAN BE EXTEND UNDERGROUND OVER TO NEW UTILITY TRANSFORMER. CONDUIT SWEEPS INTO THE TRANSFORMER SHALL BE RGS CONDUIT NOT PVC. COORDINATE EXACT ROUTING OF NEW CONDUIT WITH OWNER AND UI TO AVOID DAMAGING THE EXISTING TREE IN THIS AREA.
4. CONTRACTOR SHALL CONCRETE ENCASE NEW SERVICE ENTRANCE FEEDER (EXPOSED) AS IT ENTERS THE BUILDING OVER UNTIL IT ENTERS THE MAIN SWITCH.

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

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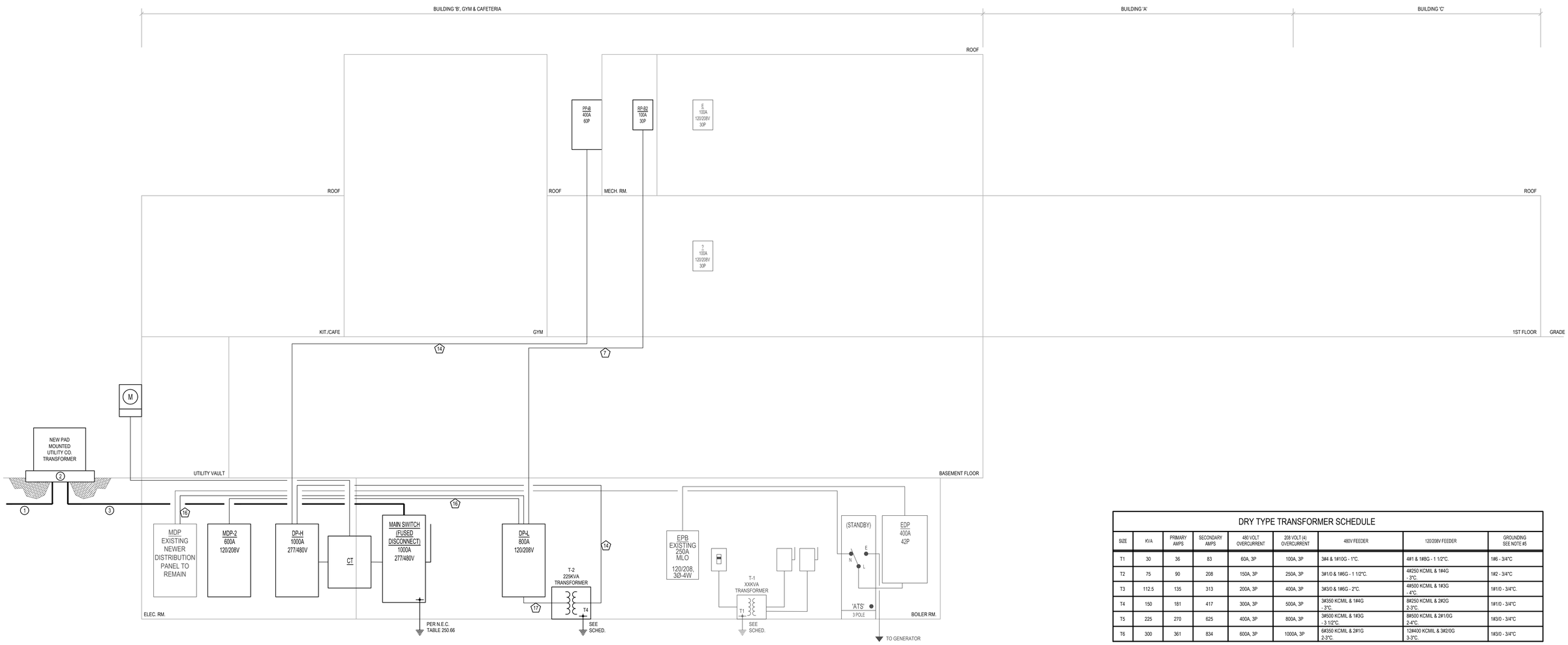
Revision:	Description:	Date:	Revised By:

Drawing Title:
PARTIAL SITE PLAN

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: SEC / PCC
Project Number: 22.335

Drawing Number: E301



1 PARTIAL ONE LINE DIAGRAM

SCALE: NONE

DRY TYPE TRANSFORMER SCHEDULE

SIZE	KVA	PRIMARY AMPS	SECONDARY AMPS	480 VOLT OVERCURRENT	208 VOLT (4) OVERCURRENT	480V FEEDER	120/208V FEEDER	GROUNDING SEE NOTE #5
T1	30	36	83	60A, 3P	100A, 3P	3#4 & 1#10G - 1"C.	4#1 & 1#8G - 1 1/2"C.	1#6 - 3/4"C
T2	75	90	208	150A, 3P	250A, 3P	3#1/0 & 1#6G - 1 1/2"C.	4#250 KCMIL & 1#4G - 3"C.	1#2 - 3/4"C
T3	112.5	135	313	200A, 3P	400A, 3P	3#3/0 & 1#6G - 2"C.	4#500 KCMIL & 1#3G - 4"C.	1#1/0 - 3/4"C.
T4	150	181	417	300A, 3P	500A, 3P	3#350 KCMIL & 1#4G - 3"C.	8#250 KCMIL & 2#2G 2-3"C.	1#1/0 - 3/4"C
T5	225	270	625	400A, 3P	800A, 3P	3#500 KCMIL & 1#3G - 3 1/2"C.	8#500 KCMIL & 2#1/0G 2-4"C.	1#3/0 - 3/4"C
T6	300	361	834	600A, 3P	1000A, 3P	6#350 KCMIL & 2#1G 2-3"C.	12#400 KCMIL & 3#2/0G 3-3"C.	1#3/0 - 3/4"C

TRANSFORMER NOTES:

1. BOND NEUTRAL OF TRANSFORMER SECONDARY TO TRANSFORMER CASE, WITH BONDING JUMPER.
2. GROUND THE CASING OF THE TRANSFORMER TO NEAREST AVAILABLE EFFECTIVELY GROUNDED WATER PIPE, STRUCTURAL STEEL AND/OR DRIVEN GROUND ROD IN ACCORDANCE WITH N.E.C. 250-30.
3. ALL CONDUCTOR SIZES ARE FOR COPPER CONDUCTORS, N.E.C. TABLE 310-15.
4. SECONDARY OVERCURRENT PROTECTION SHALL BE LOCATED WITHIN TEN (10) FEET OF THE TRANSFORMER SECONDARY TERMINALS EITHER IN A PANEL BOARD (MAIN BREAKER) OR AN INDIVIDUAL MOUNTED CIRCUIT BREAKER/DISCONNECT SWITCH.
5. TRANSFORMER BONDING JUMPER AND GROUNDING ELECTRODE CONDUCTOR.
6. 600KCMIL CONDUCTORS SHALL BE PROVIDED WITH MAC ADAPTERS AS REQUIRED TO COORDINATE WITH BREAKER LUG SIZES.

GENERAL NOTES

1. NEW UNDERGROUND PRIMARY SERVICE FEEDER FROM NEW PRIMARY SWITCH. CABLE BY U.I. IN (2) EXISTING 4" CONDUITS EXTENDED TO NEW TRANSFORMER PAD BY CONTRACTOR. REFER TO SITE PLAN E301 FOR EXACT ROUTING AND ADDITIONAL REQUIREMENTS.
2. NEW UTILITY COMPANY TRANSFORMER AND PAD. TRANSFORMER FURNISHED AND INSTALLED BY U.I. AND CONCRETE PAD FURNISHED AND INSTALLED BY CONTRACTOR. REFER TO DETAIL ON DRAWING E601.
3. NEW 1000 AMP SECONDARY FEEDER USING COPPER CONDUCTORS. PROVIDE (3) SETS OF (4) #400KCMIL IN (3) 3.5"C. REFER TO SITE PLAN E301 FOR EXACT ROUTING AND ADDITIONAL REQUIREMENTS.

CONDUCTOR AND CONDUIT SIZING TABLE, 3

NOTE	CIRCUIT BREAKER	CONDUCTOR (THWN/THHN) (3 PH, 3W) WITH GROUND	CONDUCTOR (THWN/THHN) (3 PH, 4W) WITH GROUND	CONDUIT SIZE	NOTE	CIRCUIT BREAKER	CONDUCTOR (THWN/THHN) (3 PH, 3W) WITH GROUND	CONDUCTOR (THWN/THHN) (3 PH, 4W) WITH GROUND	CONDUIT SIZE
1	20 AMP	3 #12 & 1 #12 GND	4 #12 & 1 #12 GND	3/4"	11	225 AMP	3 #4/0 & 1 #4 GND	4 #4/0 & 1 #4 GND	2 1/2"
2	25,30 AMP	3 #10 & 1 #10 GND	4 #10 & 1 #10 GND	3/4"	12	250 AMP	3 #250kcmil & 1 #4 GND	4 #250kcmil & 1 #4 GND	3"
3	35,40,45,50 AMP	3 #8 & 1 #10 GND	4 #8 & 1 #10 GND	1"	13	300 AMP	3 #350kcmil & 1 #4 GND	4 #350kcmil & 1 #4 GND	3 1/2"
4	60 AMP	3 #6 & 1 #10 GND	4 #6 & 1 #10 GND	1"	14	400 AMP	3 #600kcmil & 1 #3 GND	4 #600kcmil & 1 #3 GND	4"
5	70,80 AMP	3 #4 & 1 #8 GND	4 #4 & 1 #8 GND	1 1/4"	15	500 AMP	(2 SETS) @ 3 #250kcmil & 1 #2 GND	(2 SETS) @ 4 #250kcmil & 1 #2 GND	(2) 3"
6	90 AMP	3 #3 & 1 #8 GND	4 #3 & 1 #8 GND	1 1/2"	16	600 AMP	(2 SETS) @ 3 #350kcmil & 1 #1 GND	(2 SETS) @ 4 #350kcmil & 1 #1 GND	(2) 3 1/2"
7	100 AMP	3 #2 & 1 #8 GND	4 #2 & 1 #8 GND	1 1/2"	17	800 AMP	(2 SETS) @ 3 #600kcmil & 1 #1/0 GND	(2 SETS) @ 4 #600kcmil & 1 #1/0 GND	(2) 4"
8	125 AMP	3 #1 & 1 #6 GND	4 #1 & 1 #6 GND	2"	18	1000 AMP	(3 SETS) @ 3 #400kcmil & 1 #2/0 GND	(3 SETS) @ 4 #400kcmil & 1 #2/0 GND	(3) 3 1/2"
9	150 AMP	3 #1/0 & 1 #6 GND	4 #1/0 & 1 #6 GND	2"	19	1200 AMP	(3 SETS) @ 3 #600kcmil & 1 #4/0 GND	(3 SETS) @ 4 #600kcmil & 1 #4/0 GND	(3) 4"
10	200 AMP	3 #3/0 & 1 #6 GND	4 #3/0 & 1 #6 GND	2 1/2"	20	1600 AMP	(4 SETS) @ 3 #600kcmil & 1 #4/0 GND	(4 SETS) @ 4 #600kcmil & 1 #4/0 GND	(4) 4"

CONDUCTOR NOTES:

1. ALL VALUES BASED ON COPPER CONDUCTORS.
2. FEEDERS
   UPGRADE WIRE TO MAINTAIN MAXIMUM OF 2 % VOLTAGE DROP.
   BRANCH CIRCUITS
   UPGRADE WIRE TO MAINTAIN MAXIMUM OF 3 % VOLTAGE DROP.
3. NUMBER OF WIRES SHALL BE DETERMINED WITH EQUIPMENT ELECTRICAL NAMEPLATE CHARACTERISTICS.
4. WHERE NEUTRALS ARE REQUIRED, IT SHALL MATCH FEEDER CONDUCTOR SIZE.
5. USE CONDUCTOR (THWN/THHN) (3PH, 3W) WITH GROUND PRIMARY FEEDER FOR TRANSFORMERS.

Project Title:

Middlebrook Elementary School

Facilities HVAC Upgrade

220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES

3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

Drawing Title:

ONE LINE RISER DIAGRAM

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: SEC
Project Number: 22.335

Drawing Number: E401

LIGHTING FIXTURE SCHEDULE

DESIGNATION	DESCRIPTION	MANUFACTURER/ MODEL NUMBER	LAMP			ELECTRICAL			NOTES
			TYPE	COLOR TEMP	NO	DRIVER	VOLTAGE	WATTS	
A	RECESSED MOUNTED 2FT x 2FT FLAT PANEL LED LIGHT FIXTURE WITH FLAT OPAL LENS AND STEEL HOUSING (2500 LUMEN PACKAGE)	DAY-BRITE LIGHTING #2FPZ25L840-2-DS-UNV-DIM	LED	4000K		DIMMING	120	20.5	
AE	SAME AS TYPE 'A' EXCEPT WITH AN EMERGENCY BATTERY PACK	DAY-BRITE LIGHTING #2FPZ25L840-2-DS-UNV-DIM-BSL10LST	LED	4000K		DIMMING	120	20.5	(4)
A1E	SAME AS TYPE 'AE' EXCEPT LUMEN PACK (2000 LUMENS)	DAY-BRITE LIGHTING #2FPZ20L840-2-DS-UNV-DIM-BSL10LST	LED	4000K		DIMMING	120	16	(4)
E1	CEILING / WALL MOUNTED SINGLE FACE LED EXIT SIGN WITH RED LETTERS AND A WHITE PLASTIC HOUSING (ARROWS AS INDICATED ON PLAN)	CHLORIDE #VERVEM	LED	NA		ELECTRONIC	120	3.8	(4) (7)
E2	SAME AS TYPE 'E1' EXCEPT DOUBLE FACE	CHLORIDE #VERVEM	LED	NA		ELECTRONIC	120	3.8	(4) (7)

LIGHT FIXTURE NOTES:

1. ALL ELECTRONIC DRIVERS SHALL HAVE A MAXIMUM TOTAL HARMONIC DISTORTION OF BETWEEN TEN & FIFTEEN PERCENT (10-15%).
2. COLOR OF ALL LAMPS SHALL BE 4000K UNLESS OTHERWISE NOTED.
3. FURNISH ALL ADDITIONAL MATERIALS AND ACCESSORIES REQUIRED FOR COMPLETE INSTALLATION TO BE FULLY OPERATIONAL.
4. (4) FURNISH WITH EMERGENCY BATTERY PACK FOR MINIMUM 90 MINUTE EMERGENCY LIGHTING OPERATION WITH TEST SWITCH AND INDICATOR LIGHT.
5. CONTRACTOR SHALL VERIFY ALL CEILING TYPES AND/OR COORDINATE ALL FIXTURE TRIMS PRIOR TO PURCHASE OF FIXTURES.
6. FURNISH ALL ADDITIONAL MATERIALS AND ACCESSORIES REQUIRED FOR COMPLETE INSTALLATION TO BE FULLY OPERATIONAL.
7. (7) PROVIDE WITH FEATURES AND ACCESSORIES NECESSARY FOR UNIVERSAL MOUNTING AND DIRECTIONAL ARROW KNOCKOUTS. ARROWS ON PLAN INDICATE DIRECTION OF CHEVRONS. SHADING INDICATES QUANTITY AND LOCATION OF FIXTURE FACE.

DISTRIBUTION PANEL "DP-H" SCHEDULE

480/277 VOLTS | 3 PHASE | 4 WIRE | 65,000 AIC

MAIN BUS SIZE: 1000 AMPS | NEUTRAL: 100% | GROUND BUS: FULL

MAIN DEVICE: 1000 AMPS | MOUNTING: SURFACE

CIRCUIT NUMBER	LOAD ITEM	OVERCURRENT DEVICE			FEEDER SIZE	REMARKS
		FRAME	TRIP	POLE		
1	DP-L VIA TRANSFORMER (T-2)	400	400	3	SEE ONE LINE DIAGRAM	
2	PP-B	400	400	3	SEE ONE LINE DIAGRAM	
3	PROVISION	400	-	3	-	
4	PROVISION	225	-	3	-	
5	-	-	-	3	-	
6	-	-	-	3	-	
7	-	-	-	3	-	
8	-	-	-	3	-	

DISTRIBUTION PANEL "DP-L" SCHEDULE

208/120 VOLTS | 3 PHASE | 4 WIRE | 42,000 AIC

MAIN BUS SIZE: 800 AMPS | NEUTRAL: 100% | GROUND BUS: FULL

MAIN DEVICE: 800 AMPS | MOUNTING: SURFACE

CIRCUIT NUMBER	LOAD ITEM	OVERCURRENT DEVICE			FEEDER SIZE	REMARKS
		FRAME	TRIP	POLE		
1	MDP (EXISTING)	600	600	3	SEE ONE LINE DIAGRAM	
2	MDP-2	600	600	3	SEE ONE LINE DIAGRAM	
3	RP-2B	100	100	3	SEE ONE LINE DIAGRAM	
4	TUNNEL	100	100	3	EXISTING LOAD RECONNECTED	
5	SPARE	100	100	3	-	
6	NXEGEN	100	20	3	EXISTING LOAD RECONNECTED	
7	PROVISION	225	-	3	-	
8	PROVISION	100	-	3	-	
9	-	-	-	3	-	
10	-	-	-	3	-	
11	-	-	-	3	-	
12	-	-	-	3	-	

PANEL "MDP-2"

RATINGS: 240V/600 A, 30,000 AIC | LOCATION: ELEC/BOILER RM.
SERVICE: 208Y/120V, 3 PHS/4-WIRE | MOUNTING: SURFACE
MAIN TYPE: 600A MLO

DESCRIPTION	NOTE	AMPS	TRIP AMP	POLE	CKT. TYP	CKT. NO.	A B C	CKT. NO.	CKT. TYP	POLE	TRIP AMP	AMPS	NOTE	DESCRIPTION
1ST FLOOR SOUTH	(3)	X	100	3	C	1		2						
						3		4	C	3	225	X	(3)	KITCHEN
						5		6						
WEST WING 'A'	(3)	X	100	3	C	7		8						
						9		10	C	3	200	X	(3)	?
						11		12						
2ND FLOOR SOUTH	(3)	X	100	3	C	13		14						
						15		16	C	3	200	X	(3)	BOILER ROOM
						17		18						
HEATING CLOSET	(3)	X	100	3	C	19		20						
						21		22	C	3	150	X	(3)	HOMEMAKING 'D-3'
						23		24						
SPARE/ELEV.	(3)	X	100	3	C	25		26						
						27		28	C	3	90	X	(3)	SHOP 'D-1'
						29		30						
GROUND FLOOR	(3)	X	125	3	C	31		32						
						33		34						
						35		36						
STAGE	(3)	X	175	3	C	37		38	A1	1	20	X	(3)	ELEVATOR SHUNT-TRIP
						39		40	A1	1	20	X	(3)	EXITS
						41		42		1	20			SPARE

NOTES:
1. PANELBOARD SHALL BE MANUFACTURED BY SIEMENS OR APPROVED EQUAL.
2. (2) PROVIDE CB LOCK.
3. (3) EXISTING ACTIVE LOAD/BRANCH CIRCUIT FROM PREVIOUS DISTRIBUTION PANEL TO BE RECONNECTED TO NEW MATCHING BREAKER.
4. UPGRADE WIRE SIZE AS REQUIRED TO MAINTAIN 3% MAXIMUM VOLTAGE DROP.
5. TOTAL CONNECTED NEW LOAD: PHASE A - X VA, PHASE B - X VA, PHASE C - X VA } X KVA BASED ON X AMPS/PHASE
6. NOT USED
7. CIRCUIT TYPE A1: 120V, 3 WIRE IN CONDUIT OR MC CABLE.
8. CIRCUIT TYPE B: 208V, 1Ø, 4 WIRE IN CONDUIT OR MC CABLE.
9. CIRCUIT TYPE C: 208V, 3Ø, 5 WIRE IN CONDUIT OR MC CABLE.

PANEL "PP-B"

RATINGS: 480V/400 A, 30,000 AIC | LOCATION: ROOF
SERVICE: 480Y/277V, 3 PHS/4-WIRE | MOUNTING: SURFACE
MAIN TYPE: 400A MLO

DESCRIPTION	NOTE	AMPS	TRIP AMP	POLE	CKT. TYP	CKT. NO.	A B C	CKT. NO.	CKT. TYP	POLE	TRIP AMP	AMPS	NOTE	DESCRIPTION
						1		2						
HP-1 (ROOF)	(3)	17	25	3	C	3		4	C	3	35	24.7	(3)	DOAS-3 (ROOF)
						5		6						
DOAS-1 (ROOF)	(3)	24.7	35	3	C	7		8						
						9		10	C	3	25	17	(3)	HP-1 (ROOF)
						11		12						
DOAS-2 (ROOF)	(3)	24.7	35	3	C	13		14						
						15		16	C	3	35	24.7	(3)	DOAS-4 (ROOF)
						17		18						
HP-2 (ROOF)	(3)	17	25	3	C	19		20						
						21		22	C	3	25	17	(3)	HP-2 (ROOF)
						23		24						
HP-3 (ROOF)	(3)	17	25	3	C	25		26						
						27		28	C	3	25	17	(3)	HP-4 (ROOF)
						29		30						
HP-3 (ROOF)	(3)	17	25	3	C	31		32						
						33		34	C	3	25	17	(3)	HP-4 (ROOF)
						35		36						
						37		38						
						39		40						
						41		42						

NOTES:
1. PANELBOARD SHALL BE MANUFACTURED BY SIEMENS OR APPROVED EQUAL.
2. (2) PROVIDE CB LOCK.
3. (3) PROVIDE HACR BREAKER.
4. UPGRADE WIRE SIZE AS REQUIRED TO MAINTAIN 3% MAXIMUM VOLTAGE DROP.
5. TOTAL CONNECTED NEW LOAD: PHASE A - 65039.6 VA, PHASE B - 65039.6 VA, PHASE C - 65039.6 VA } 195.1 KVA BASED ON 234.8 AMPS/PHASE
6. PANEL SHALL BE PROVIDED WITH A NEMA 3R RATED ENCLOSURE, SUITABLE TO BE INSTALLED OUTDOORS.
7. CIRCUIT TYPE A1: 277V, 3 WIRE IN CONDUIT OR MC CABLE.
8. CIRCUIT TYPE B: 480V, 1Ø, 4 WIRE IN CONDUIT OR MC CABLE.
9. CIRCUIT TYPE C: 480V, 3Ø, 5 WIRE IN CONDUIT OR MC CABLE.

PANEL "RP-B2"

RATINGS: 240V/100 A, XX,000 AIC (MATCH EXISTING) | LOCATION: MECH. RM.
SERVICE: 208Y/120V, 3 PHS/4-WIRE | MOUNTING: SURFACE
MAIN TYPE: 100A MLO

DESCRIPTION	NOTE	AMPS	TRIP AMP	POLE	CKT. TYP	CKT. NO.	A B C	CKT. NO.	CKT. TYP	POLE	TRIP AMP	AMPS	NOTE	DESCRIPTION
RECEPTACLES (ROOF)		4.5	20	1	A1	1		2	A1	1	20	4.5		RECEPTACLES (ROOF)
FCU-B2-0, 1A, 1B, 2A, 2B, 6A, 6B, 7A, 7B & BC-1	(3)	2.85	15	2	B	3		4	B	2	15	2.85	(3)	FCU-B2-5, 3A, 3B, 4A, 4B, 8A, 8B, 9A, 9B, & BC-2
						5		6						
FCU-B1-0, 1A, 1B, 2A, 2B, 6A, 6B, 7A, 7B & BC-1	(3)	2.85	15	2	B	7		8	B	2	15	2.85	(3)	FCU-B1-3, 4A, 4B, 5, 8A, 8B, 9A, 9B, & BC-2
						9		10						
						11		12						
						13		14						
						15		16						
						17		18						
						19		20						
						21		22						
						23		24						
						25		26						
						27		28						
						29		30						

NOTES:
1. PANELBOARD SHALL BE MANUFACTURED BY SIEMENS OR APPROVED EQUAL.
2. (2) PROVIDE CB LOCK.
3. (3) PROVIDE HACR BREAKER.
4. UPGRADE WIRE SIZE AS REQUIRED TO MAINTAIN 3% MAXIMUM VOLTAGE DROP.
5. TOTAL CONNECTED NEW LOAD: PHASE A - 1764 VA, PHASE B - 1368 VA, PHASE C - 684 VA } 3.8 KVA BASED ON 10.6 AMPS/PHASE
6. CIRCUIT TYPE A: 120V, 2 WIRE IN CONDUIT OR MC CABLE.
7. CIRCUIT TYPE A1: 120V, 3 WIRE IN CONDUIT OR MC CABLE.
8. CIRCUIT TYPE B: 208V, 1Ø, 4 WIRE IN CONDUIT OR MC CABLE.
9. CIRCUIT TYPE C: 208V, 3Ø, 5 WIRE IN CONDUIT OR MC CABLE.

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
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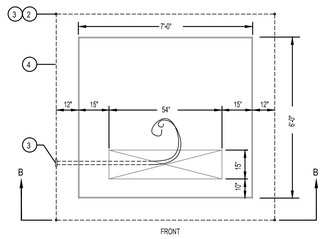
Revision:	Description:	Date:	Revised By:

Drawing Title:
LIGHT FIXTURE & PANEL BOARD SCHEDULES
State Project #144-_ _ _ _ _ _

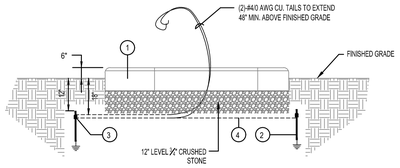
Date: 2-09-2024
Scale: AS NOTED
Drawn By: SEC
Project Number: 22.335

Drawing Number: E501

FIG. 2
GROUNDING AND BONDING DETAILS

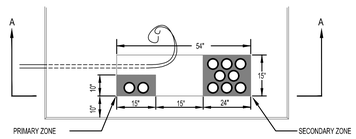


NOTE: CRITICAL -
1. GROUND GRID CONNECTORS MUST BE U.I. APPROVED BREAKOFF TYPE CONNECTOR OR EXOTHERMAL WELDS.
2. GROUND GRID CONNECTIONS SHOULD BE LEFT EXPOSED FOR INSPECTION BY U.I.
3. INSPECTION SCHEDULING REQUIRES TWO FULL WORKING DAYS NOTICE.

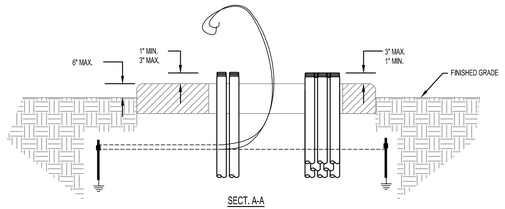


SECT. B-B

FIG. 1
CONDUIT INSTALLATION DETAILS

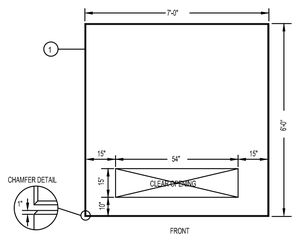


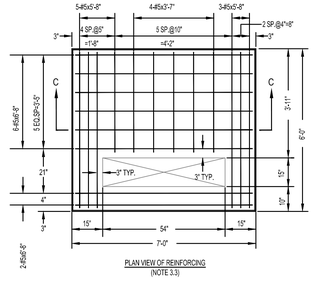
NOTE: CRITICAL -
PRIMARY AND SECONDARY CONDUITS MUST FALL WITHIN SHADED AREA INDICATED.



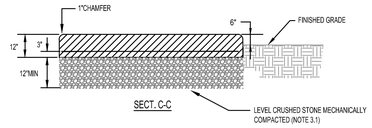
SECT. A-A

FIG. 3
CONCRETE DETAILS
(NOTE 3.2)





PLAN VIEW OF REINFORCING
(NOTE 3.3)



SECT. C-C

FIGURE 1:

1. PRIMARY ZONE

A. THE PRIMARY ZONE IS RESTRICTED TO THE AREA SHOWN AND WILL CONTAIN TWO 4" G.S. CONDUITS.

B. THE CONDUIT SWEEPS INTO THE FOUNDATION SHALL BE GALVANIZED STEEL, 90 DEG. BEND AND 36" RADIUS.

C. EACH CONDUITS SHOULD EXTEND A MINIMUM OF 1" TO A MAXIMUM OF 3" ABOVE THE TOP OF THE FOUNDATION AND SHALL HAVE THREADED ENDS.

D. EACH CONDUIT SHALL BE PROVIDED WITH A GROUNDING TYPE CHAFE BUSHING AND SHALL BE PLUGGED UNTIL THE PRIMARY CABLES ARE INSTALLED.

2. SECONDARY ZONE

E. THE SECONDARY ZONE IS RESTRICTED TO THE AREA SHOWN ABOVE AND MAY CONTAIN A MAXIMUM OF EIGHT 4" CONDUITS.

F. INSTALLATION OF THE REQUIRED NUMBER, SIZE AND TYPE OF CONDUITS BROUGHT INTO THE FOUNDATION SHALL COMPLY WITH ALL APPLICABLE PROVISIONS OF THE NEC AND WITH THE LOCAL AUTHORITY HAVING JURISDICTION.

G. EACH CONDUITS SHOULD EXTEND A MINIMUM OF 1" TO A MAXIMUM OF 3" ABOVE THE TOP OF THE FOUNDATION. WHEN METAL CONDUITS ARE USED, THEY SHALL HAVE THREADED ENDS.

H. METAL CONDUITS SHALL BE PROVIDED WITH GROUNDING TYPE CHAFE BUSHINGS AND EACH CONDUIT SHALL BE PLUGGED UNTIL THE SECONDARY CABLES ARE INSTALLED.

3. THE RESTRICTIONS ON THE NUMBER OF CONDUITS ALLOWED IN THE SECONDARY ZONE ARE BASED UPON PHYSICAL LIMITATIONS.

4. WHEN THE SECONDARY CONDUCTOR SIZE EXCEEDS 500MCM, A MAXIMUM OF SIX CONNECTIONS PER PHASE ARE POSSIBLE.

FIGURE 2:

1. FOUR COPPERWELD GROUND RODS AND A #4/0 AWG BARE COPPER GROUND GRID SHALL BE INSTALLED AND CONNECTED WITH (5) APPROVED GROUND GRID CONNECTORS AS SHOWN.
2. THE GROUND GRID 'TAILS' SHALL BE BROUGHT BELOW GRADE, INTO THE FOUNDATION WINDOW AS SHOWN.
3. THE GROUND RODS, GROUND GRID, PRIMARY NEUTRALS, SECONDARY NEUTRALS, TRANSFORMER TANK AND METAL CONDUITS SHALL ALL BE EFFECTIVELY BONDED TOGETHER.
4. ALL GROUNDING AND BONDING SHALL BE DONE WITH COPPER WIRE. THE MINIMUM CONDUCTOR SIZE FOR BONDING METAL CONDUITS IS #4 AWG BARE COPPER; ALUMINUM WIRE IS NOT ACCEPTABLE.
5. GROUNDING BUSHINGS SHALL BE USED FOR BONDING ALL METAL CONDUITS.
6. THE GROUND GRID AND ASSOCIATED CONNECTIONS REQUIRE U.I. INSPECTION PRIOR TO BACKFILLING THE AREA.

FIGURE 3:

1. A COMPACTED BASE OF CRUSHED STONE 12" MINIMUM DEPTH SHALL BE INSTALLED ON A LEVEL COMPACTED SUB-GRADE WITH MINIMUM SOIL BEARING CAPACITY OF 1,000 POUNDS PER SQUARE FOOT.
2. CONCRETE SHALL CONFORM WITH ACI BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE AND SHALL HAVE A MINIMUM ULTIMATE STRENGTH (FC) OF 3,000 PSI AT 28 DAYS, A MAXIMUM OF 1 1/2" COARSE AGGREGATE AND AIR ENTRAINMENT FOR A TOTAL AIR CONTENT OF 3% - 6% BY VOLUME.
3. REINFORCING STEEL SHALL BE NEW, DEFORMED BARS MEETING ASTM A615 SPECIFICATIONS FOR GRADE NO. 60 STEEL. THE REINFORCING SHOWN IS TYPICAL FOR FIELD FABRICATION.
4. A PRE-CAST FOUNDATION WILL REQUIRE LIFTING EYES AND MAY REQUIRE ADDITIONAL REINFORCING TO HANDLE THE STRESSES OF TRANSPORTATION AND SETTING IN PLACE.
5. THE TOP SURFACE SHALL BE SMOOTH AND LEVEL WITH A 1" CHAMFER ALONG THE UPPER EDGES.

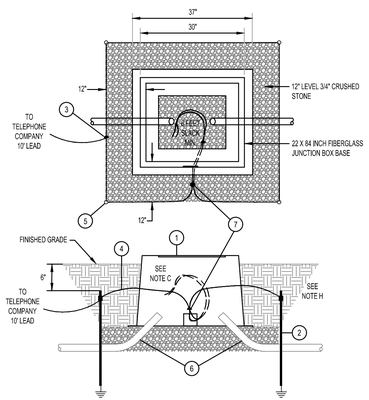
FIGURE 4:

1. THE LOCATION AND ORIENTATION OF THE FOUNDATION MUST BE APPROVED BY U.I. PRIOR TO THE START OF CONSTRUCTION. SEE U.I. STANDARDS 20501, 20503, 23005 FOR LOCATION AND INSTALLATION REQUIREMENTS.

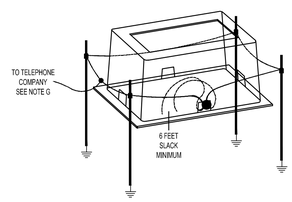
FOUNDATION FOR U.I. 3Ø PAD-MOUNTED TRANSFORMER DETAIL

75kVA THRU 1000kVA (120/208Y VOLT SEC.)
225kVA THRU 1000kVA (277/480Y VOLT SEC.)

1 NTS



LIST OF MATERIALS			
ITEM	QTY.	SYM. NO.	DESCRIPTION
1	1	40-09520	BOX PAD - 3PH FG - 22x84 - 200 AMP ELBOW JUNCTIONS
2	4	43-87600	ROD GROUND GALVANIZED STEEL, 5/8" DIA. x 8'
3	2	58-39600	CONNECTOR 4 SOLID
4	± 35°	96-84900	GRD. WIRE #4 CU STRANDED BARE SD
5	4	58-40700	CONNECTOR W/HEX HEAD BOLT
6	* *	32-58182	ELBOW, CONDUIT, 4" PVC, 45°, 24"R, SCH. 40
7	1	58-39400	CONN "COPPER BUG" 2S



NOTES:
THE DIMENSIONS OF THE BOX PADS, FOR SPECIFIC PAD MOUNTED EQUIPMENT , ARE GIVEN BELOW:

	BOX			TOP OPENING	
	W (WIDTH)	D (DEPTH)	H (HEIGHT)	A (WIDTH)	B (DEPTH)
1PH TRANSFORMER/ SPLICE/JUNCTION	37-1/2	43	32	26	24
3PH JUNCTIONS	85	23	30	72	15

A. (1) FOR TRANSFORMER INSTALLATIONS, THE FRONT OF THE TRANSFORMER MUST BE LOCATED ON THE NARROW SIDEWALL, NORMALLY 37-1/2" WIDE.
(2) FOR SINGLE PHASE JUNCTION ENCLOSURE INSTALLATIONS, THE FRONT OF THE ABOVE GRADE JUNCTION ENCLOSURE MUST BE LOCATED ALONG THE WIDE SIDEWALL, NOMINALLY 43"WIDE.

B. THE SYSTEM SHALL BE EFFECTIVELY GROUNDED WITH FOUR GROUND RODS AND A #4 AWG BARE CU GROUND GRID.

C. THE GROUND GRID SHALL BE INSTALLED AND CONNECTED AS SHOWN. THE GROUND GRID "TAILS" SHALL BE BUGGED TOGETHER AND THEN BROUGHT BELOW GRADE, INTO THE BOX PAD. EACH END SHALL BE SUFFICIENT LENGTH TO CONNECT TO THE TRANSFORMER TANK GROUND, CABLE/SPLICE NEUTRAL OR EQUIPMENT GROUND BUS (MINIMUM OF 6 FEET OF WIRE INSIDE THE BOX PAD).

D. ALL CONDUCTOR NEUTRALS AND EQUIPMENT GROUNDS SHALL BE BONDED TOGETHER AND CONNECTED TO THE GROUND GRID. SEE APPROPRIATE EQUIPMENT DCS FOR DETAILS.

E. LOCATE THE BOX PAD IN ACCORDANCE WITH THE REQUIREMENTS OF DCS-20501 ENSURING THAT THE BOX PAD FRONT, DEPENDING ON EQUIPMENT TO BE USED, IS POSITIONED IN THE REQUIRED DIRECTION.

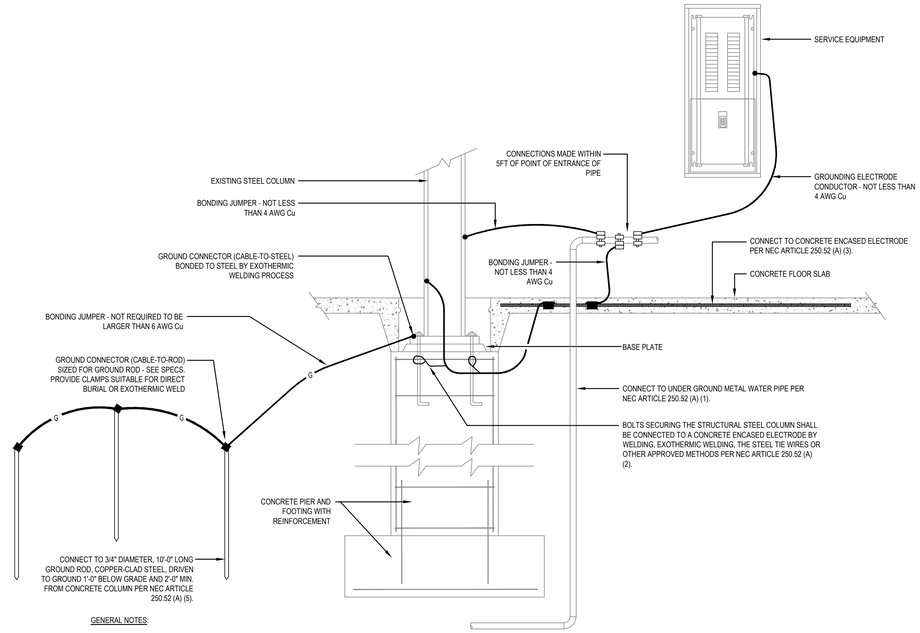
F. PRIMARY, SECONDARY AND SERVICE CONDUITS SHALL ENTER FROM BELOW THE BOX PAD LIP.

G. A TELEPHONE COMPANY GROUND LEAD (10' LONG MINIMUM) MUST BE PROVIDED WHEN TELEPHONE COMPANY FACILITIES COME WITHIN THE IMMEDIATE VICINITY OF UI COMPANY FACILITIES. THE GROUND LEAD SHALL BE LOCATED ON THE SIDE OF THE TRANSFORMER/ENCLOSURE CLOSETS TO THE TELEPHONE COMPANY FACILITIES.

H. FOR GROUNDING IN BEDROCK, SEE DCS-19821 "GROUNDING IN BEDROCK SINGLE PHASE TRANSFORMERS".

I. THE FOUNDATION SHALL HAVE A 12" BASE OF FIRM, LEVEL, COMPACTED 3/4" CRUSHED STONE. THE CRUSHED STONE SHALL EXTEND 12 INCHES BEYOND THE PERIMETER OF THE STRUCTURE. THE COMPACTED CRUSHED STONE SHALL BE INSTALLED ON A LEVEL, COMPACTED SUB-GRADE WITH A MINIMUM SOIL BEARING CAPACITY OF 1,000 POUNDS PER SQUARE FOOT.

2 FIBERGLASS FOUNDATION DETAIL FOR PAD MOUNTED UTILITY CO. EQUIPMENT
NTS



GENERAL NOTES:

1. PROVIDE GROUNDING ELECTRODE SYSTEM PER NEC ARTICLE 250.50. ALL GROUNDING ELECTRODES AS DESCRIBED IN 250.52 (A) (1) THROUGH (A) (7) THAT ARE PRESENT AT EACH BUILDING OR STRUCTURE SERVED SHALL BE BONDED TOGETHER TO FORM THE GROUNDING ELECTRODE SYSTEM.

3 TYPICAL SERVICE GROUNDING DETAIL
NTS

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

SILVER PETRUCELLI + ASSOCIATES
3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
203 230 9007 silverpetrucelli.com

Revision:	Description:	Date:	Revised By:

Drawing Title:
DETAILS

State Project #144-_ _ _ _ _ _

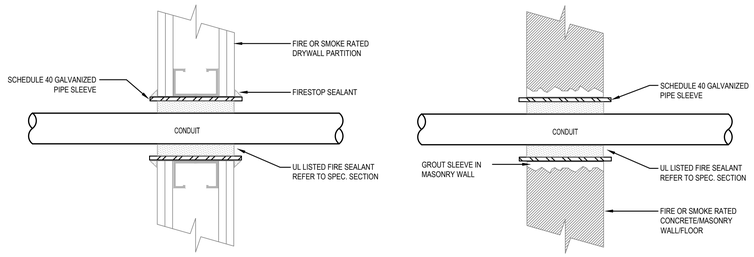
Date: 2-09-2024
Scale: AS NOTED
Drawn By: SEC
Project Number: 22.335

Drawing Number:
E601

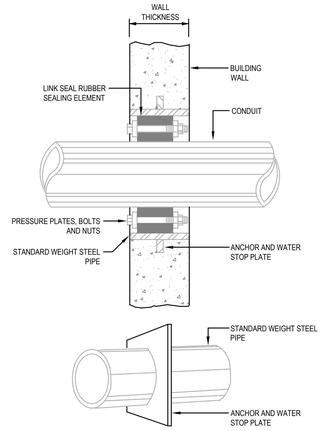
GENERAL NOTES:

PROVIDE UL LISTED FIRE/SMOKE PENETRATION ASSEMBLY IN ACCORDANCE W/ UL1479, ASTM E814 REQUIREMENTS FOR WALL TYPE, RATING, PIPE SIZE INSTALLED.

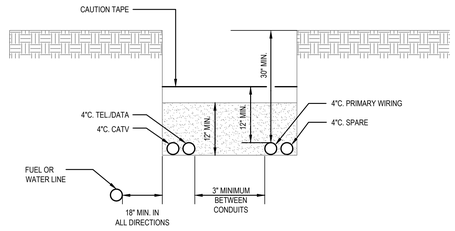
FIRE STOPPING SHALL HAVE A RATING EQUAL TO OR GREATER THAN THE WALL/FLOOR BEING PENETRATED - SEE SPECIFICATIONS. REFER TO ARCHITECTURAL DRAWINGS FOR WALL/FLOOR RATINGS AND LOCATIONS.



1 WALL/FLOOR PENETRATION W/FIRE-SMOKE SEAL DETAIL
NTS



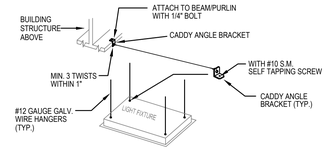
2 WATER-TIGHT WALL SLEEVE
NTS



INSTALLATION IN TRENCH
- ALL CONDUIT SHALL BE INSTALLED AT A DEPTH OF AT LEAST 36" IN THE FOLLOWING ORDER:

1. ENSURE THAT THE BOTTOM OF THE TRENCH IS WELL-TAMPED AND FREE OF ROCKS.
2. INSTALL THE CONDUIT,
3. INSTALL OTHER UTILITY CABLES OR CONDUITS IN THE TRENCH.
4. BACKFILL WITH 12 INCHES OF SAND.
5. INSTALL CABLE WARNING TAPE 12 INCHES OVER THE CONDUIT.
6. FILL IN THE REMAINDER OF THE TRENCH WITH NATIVE BACKFILL.

3 TRENCH DETAIL
NTS



NOTES:

1. ALL LIGHTING FIXTURES SHALL BE SECURED TO THE STRUCTURE BY THE ELECTRICAL CONTRACTOR.
2. FLUSH OR RECESSED LIGHT FIXTURES LESS THAN 56 POUNDS SHALL HAVE 2 - 12 GA. SLACK SAFETY WIRES FROM DIAGONAL CORNERS TO BUILDING STRUCTURE BY TRADE CONTRACTOR.
3. FLUSH OR RECESSED LIGHT FIXTURES MORE THAN 56 POUNDS SHALL HAVE 4 - 12 GA. SLACK SAFETY WIRES FROM DIAGONAL CORNERS TO BUILDING STRUCTURE BY TRADE CONTRACTOR.
4. SECURE SURFACE MOUNTED LIGHT FIXTURES W/ MINIMUM OF 2 - POSITIVE CLAMPING DEVICES OF 14 GA. MINIMUM STEEL AND W/ 12 GA. WIRE TO BUILDING STRUCTURE.

4 TYPICAL LAY-IN GRID LIGHTING FIXTURE SUPPORT/MOUNTING DETAIL
NTS

Project Title:
Middlebrook Elementary School
Facilities HVAC Upgrade
220 Middlebrook Avenue
Trumbull, CT 06611

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3190 WHITNEY AVENUE HAMDEN CT 06518
311 STATE STREET NEW LONDON CT 06320
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Revision:	Description:	Date:	Revised By:

Drawing Title:
DETAILS

State Project #144-_ _ _ _ _ _

Date: 2-09-2024
Scale: AS NOTED
Drawn By: SEC
Project Number: 22.335

Drawing Number:
E602

Town of Trumbull

Middlebrook Elementary School HVAC

11/6/2023

Professional Cost Estimate **18,123 Sq. Feet**

Task	Unit	Takeoff Quantity	Total Cost / Unit	Total Project Development Cost	CT Grant Ineligible Costs
Division 1 - General Requirements					
State Permits (.26 cents/ $1,000)				$913	$913
100% Payment & Performance Bond (1.5%)				$52,644	$0
Liability Insurance (1.5%)				$52,644	$0
Daily Final Cleaning	SF	18123	$0	$4,531	$0
Rubbish Removal/ Dumpster	LS	3	$1,000	$3,000	$0
Selective Ceiling Demolition	SF	18123	$3	$54,369	$0
Selective Roof Demolition	LS	1	$10,000	$10,000	$0
Demo Flooring & Wall Base	SF	5320	$3	$13,300	$0
Testing and Abatement	LS	1	$50,000	$50,000	$0
Subtotal				**$241,401**	**$913**
Division 2 - Existing Conditions					
02 41 19 Building Demolition - Concrete Slab	CF	54	$100	$5,400	$0
02 41 16 Building Demolition (Soffits)	LS	1	$1,500	$1,500	$0
02 41 19 Concrete Demolition (Utility Room)	CF	34	$100	$3,400	$0
02 41 19 Partition Wall Demolition	LS	1	$2,000	$2,000	$0
Subtotal				**$12,300**	
Division 3 - Concrete					
03 21 11 Reinforcing In Place	LS	1	$6,500	$6,500	
03 30 00 Cast-In-Place Concrete (Ret. Wall)	CY	7	$2,000	$14,000	$0
03 30 00 Cast-In-Place Concrete (Footings)	EA	4	$3,000	$12,000	$0
Subtotal				**$32,500**	
Division 4 - Unit Masonry					
04 22 10 Concrete Block Partitions, 6" Thick	SF	1250	$40	$50,000	$0
Subtotal				**$50,000**	
Division 5 - Metals					

05 41 13 2x4 Steel Framing	LF	15	$60.00	$900	$0
05 42 23 2x4 Steel Framing (Soffits)	LF	1200	$8.25	$9,900	$0
05 41 13 2x6 Steel Framing	LF	10	$100.00	$1,000	
05 51 19 Metal Stairs (Utility Room)	LS	1	$2,000.00	$2,000	
05 52 13.50 Railings, Pipe (Retaining Wall)	LS	1	$12,500.00	$12,500	
Aluminum Brake Metal For Window Mullion	LS	1	$2,000.00	$2,000	
Subtotal				**$28,300**	
Division 6 - Woods, Plastics & Composites					
06 20 23 Solid Surface Counter Tops	SF	15	$250.00	$3,750	$0
Subtotal				**$3,750**	
Division 7 - Thermal and Moisture Protection					
07 13 26 Self-Adhering Sheet Waterproofing	SF	5	$420.00	$2,100	$0
07 21 16 Sound Insulation for Soffits	SF	800	$3.00	$2,400	$0
07 31 13 Roof Flashing at Curbs/Pitch Boxes	SF	160	$210.00	$33,600	$0
07 84 13 Penetration Firestopping	SF	425	$35.00	$14,875	$0
07 92 00 Joint Sealants	LF	750	$6.00	$4,500	$0
Allowance - rework exst framing for new ducts	LS	1	$9,360.00	$9,360	$9,360
Subtotal				**$66,835**	**$9,360**
Division 9 - Finishes					
09 05 05 Demolition - Suspended Ceiling	LS	1	$2,000.00	$2,000	$0
09 29 10 Gypsum board (Soffits)	SF	800	$3.75	$3,000	$0
09 51 23 Suspended Ceiling (Corridors)	SF	3,700	$8.00	$29,600	$0
09 65 13 Resilient Base and Accessories	LF	125	$7.00	$875	$0
09 91 23.39 Interior Painting - Walls	SF	1,300	$5.00	$6,500	$0
09 91 23.39 Interior Painting - Soffits	SF	800	$5.00	$4,000	$0
Subtotal				**$45,975**	**$0**
Division 21 - Fire Protection					
Startup and Mobilization	LS	1	$9,143.00	$11,429	$0
Piping, fittings, hangers, etc.	LS	1	$54,876.00	$54,876	$0
Testing / Demolition	LS	1	$4,000.00	$4,000	$0
misc.	LS	1	$5,000	$5,000	$0
Subtotal				**$75,305**	**$0**

Division 22 - Plumbing					
Startup and Mobilization	LS	1.25	$23,492.00	$29,365	$0
Demolition	LS	1.25	$6,000.00	$7,500	$0
Natural Gas Piping and Specialties	LS	1.25	$37,471.00	$46,839	$0
Condensate Piping and Specialties	LS	1.25	$21,745.00	$27,181	$0
misc.		1.25	$5,000.00	$6,250	$0
Subtotal				**$117,135**	**$0**

Division 23 - Mechanical					
Startup and Mobilization	EA	18,123	$0.10	$1,740	$0
Demolition	LOT	1	$12,000.00	$12,000	$0
DOAS - Nat'l Gas-fired / Dx	EA	4	$157,500.00	$630,000	$0
DOAS Associated Ductwork	LOT	1	$446,066.78	$446,067	$0
VRF Hyper Heat Systems w/ Energy Recovery	TON	48	$13,725.00	$658,800	$0
Testing and Balancing	LOT	1	$9,375.00	$9,375	$0
BMS Controls	LOT	18,123	$12.00	$217,476	$0
Subtotal				**$1,975,458**	**$0**

Division 26 - Electrical					
NEW ELEC. SERVICE					
Utility Cost	LOT	1	$25,000.00	$25,000	
Extend Existing Primary Conduits (2-4")	LOT	1	$7,500.00	$7,500	
480V Secondary Feeder (75')	LOT	1	$30,000.00	$30,000	
480V Distribution Panel (1000 amp)	EA	1	$20,000.00	$20,000	
208V Distribution Panel (800 amp)	EA	1	$18,000.00	$18,000	
225 KVA Transformer	EA	1	$23,000.00	$23,000	
1200 amp Fused Disconnect Switch (Main)	EA	1	$18,000.00	$18,000	
CT Cabinet (48"x48"x12")	EA	1	$5,000.00	$5,000	
Panel Feeders (both 480V & 208V)	LOT	1	$55,000.00	$55,000	
BLDG 'B' ELEC					
New Lighting (2x2's & Exit Signs)	LOT	1	$13,000.00	$13,000	
480V Power Panel (400 amp) 3R Rated	EA	1	$28,000.00	$28,000	
208V Branch Panel (100 amp)	EA	1	$10,000.00	$10,000	
Mechanical Connections (35A-3P) 480V	EA	4	$3,500.00	$14,000	
Mechanical Connections (25A-3P) 480V	EA	8	$2,500.00	$20,000	
Mechanical Connections (15A-2P) 208V	EA	2	$4,500.00	$9,000	
Misc. 120V Connections	LOT	1	$5,000.00	$5,000	
400 amp Feeder (250') 480V	LOT	1	$45,000.00	$45,000	
100 amp Feeder (300') 208V	LOT	1	$18,000.00	$18,000	$0
Subtotal				**$363,500**	**$0**

Division 31 - Earthwork					
Excavation & Removal	LS	1	$10,000.00	$10,000	
Rough Grading	LS	1	$2,000.00	$2,000	
Subtotal				**$12,000**	
			SUBTOTAL (INCLUDING O&P):	$3,024,458	$10,273
			GENERAL CONDITIONS (15%):	$453,669	$137
Construction Total				**$3,478,127**	**$10,410**

SOFT COSTS:		
CONSTRUCTION CONTINGENCY (10%):	$347,813	$347,813
DESIGN CONTINGENCY (5%):	$173,906	$173,906
A&E FEES (6%):	$208,688	$63
SOFT COST SUBTOTAL:	$730,407	$521,782
TOTAL PROJECT COST:	**$4,208,534**	**$532,192**

TOWN OF TRUMBULL, CONNECTICUT
BOARD OF EDUCATION

REQUEST FOR PROPOSAL

MIDDLEBROOK ELEMENTARY SCHOOL
FACILITIES HVAC UPGRADE
220 MIDDLEBROOK AVENUE
TRUMBULL, CONNECTICUT 06611

STATE PROJECT #144-____ __
S/P+A PROJECT #22.335
BID #____

Town Officials

Building Inspector _____	Fire Marshal _____
Health Inspector _____	ADA/504 Coordinator _____

CD Submission: February 9, 2024

PREPARED FOR THE TOWN OF TRUMBULL BY:

Architects | Engineers | Interior Designers
Silver Petrucelli + Associates, Inc.
3190 Whitney Avenue, Hamden, CT 06518
311 State Street, New London, CT 06320

Town Officials

Building Inspector	Fire Marshal
Sanitation/Health Inspector	ADA/504 Coordinator

FACILITIES HVAC UPGRADE

MIDDLEBROOK ELEMENTARY SCHOOL
220 MIDDLEBROOK AVENUE
TRUMBULL, CT 06611
STATE PROJECT #144-____
BID #__/__-__

S/P+A PROJECT NO. 22.335

DIVISION 00 – PROCUREMENT AND CONTRACT REQUIREMENTS — PAGES

	CHRO Contract Compliance Regulations Notification To Bidders	5
	Instructions to Bidders (AIA A701)	8
	Supplementary Instructions to Bidders	5
	Standard Form of Agreement between Owner and Contractor (AIA A101)	8
	General Conditions of the Contract for Construction (AIA A201)	39
	Supplementary General Conditions	6
	Project Application and Project Certificate for Payment (AIA G702)	1
	Project Application Continuation Sheet (AIA G703)	1
	2022-23, 2023-24, and 2024-25 School Calendars	3
	Drawing List	2

DIVISION 01 – GENERAL REQUIREMENTS

Section 011000	Summary of Work	4
Section 012300	Alternates	2
Section 012500	Substitution Procedures	4
Section 012600	Contract Modification Procedures	2
Section 012900	Payment Procedures	4
Section 013100	Project Management and Coordination	6
Section 013200	Construction Progress Documentation	6
Section 013233	Photographic Documentation	2
Section 013300	Submittal Procedures	9
Section 014000	Quality Requirements	8
Section 014200	References	7
Section 015000	Temporary Facilities and Controls	4
Section 016000	Product Requirements	5
Section 017300	Execution	7
Section 017700	Closeout Procedures	3
Section 017823	Operation and Maintenance Data	7
Section 017839	Project Record Documents	3
Section 017900	Demonstration and Training	4

DIVISION 02 – EXISTING CONDITIONS

Section 024119	Selective Demolition	7

DIVISION 03 – CONCRETE

Section 033000	Cast-In-Place Concrete	13

DIVISION 04 – MASONRY

Section 042200	Concrete Unit Masonry	10

DIVISION 05 – METALS

Section 055000	Metal Fabrications	6
Section 055119	Metal Grating Stairs	6
Section 055213	Pipe and Tube Railings	7

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

Section 078413	Penetration Firestopping	4
Section 079200	Joint Sealants	6

DIVISION 09 – FINISHES

Section 092216	Non-Structural Metal Framing	3
Section 092900	Gypsum Board	6
Section 095113	Acoustical Panel Ceilings	7
Section 096513	Resilient Base and Accessories	4
Section 099113	Exterior Painting	5
Section 099123	Interior Painting	6

DIVISION 12 – FURNISHINGS

Section 123661.16	Solid Surfacing Countertops	3

DIVISION 21 – FIRE PROTECTION

Section 210517	Sleeves and Sleeve Seals for Fire-Suppression Piping	5
Section 210518	Escutcheons for Fire-Suppression Piping	2
Section 211313	Wet-Pipe Sprinkler Systems	9

DIVISION 22 – PLUMBING

Section 220517	Sleeves and Sleeve Seals for Plumbing Piping	4
Section 220518	Escutcheons for Plumbing Piping	2
Section 220519	Meters and Gages for Plumbing Piping	4
Section 220529	Hangers and Supports for Plumbing Piping and Equipment	11
Section 221316	Sanitary Waste and Vent Piping	10
Section 221623	Facility Natural-Gas Piping	14

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING

Section 230000	Basic Mechanical Requirements	4
Section 230513	Common Motor Requirements for HVAC Equipment	3
Section 230517	Sleeves and Sleeve Seals for HVAC Piping	4
Section 230518	Escutcheons for HVAC Piping	2
Section 230529	Hangers and Supports for HVAC Piping and Equipment	9
Section 230548	Vibration and Seismic Controls for HVAC	12

Section 230553	Identification for HVAC Piping and Equipment	5
Section 230593	Testing, Adjusting, and Balancing for HVAC	20
Section 230700	HVAC Insulation	30
Section 230923	Direct Digital Control (DDC) System for HVAC	62
Section 230993	Sequence of Operations for HVAC Controls	8
Section 232300	Refrigerant Piping	9
Section 233113	Metal Ducts	13
Section 233300	Air Duct Accessories	18
Section 233346	Flexible Ducts	2
Section 233423	HVAC Power Ventilators	5
Section 233713	Diffusers, Registers, and Grilles	3
Section 237433	Dedicated Outdoor-Air Units	15
Section 238129	Variable-Refrigerant-Flow HVAC Systems	42

DIVISION 26 – ELECTRICAL

Section 260500	Common Work Results for Electrical	4
Section 260509	Electrical Demolition Requirements	2
Section 260519	Low-Voltage Electrical Power Conductors and Cables	5
Section 260523	Control-Voltage Electrical Power Cables	10
Section 260526	Grounding and Bonding for Electrical Systems	7
Section 260529	Hangers and Supports for Electrical Systems	6
Section 260533	Raceway and Boxes for Electrical Systems	11
Section 260543	Underground Ducts and Raceways for Electrical Systems	15
Section 260553	Identification for Electrical Systems	10
Section 260572	Overcurrent Protective Short-Circuit Study	6
Section 262416	Panelboards	10
Section 262713	Electricity Metering	4
Section 262726	Wiring Devices	6
Section 262813	Fuses	3
Section 262816	Enclosed Switches and Circuit Breakers	9
Section 265119	LED Interior Lighting	7

END OF TABLE OF CONTENTS

COMMISSION ON HUMAN RIGHTS AND OPPORTUNITIES
CONTRACT COMPLIANCE REGULATIONS
NOTIFICATION TO BIDDERS
(Revised 09/3/15)

The contract to be awarded is subject to contract compliance requirements mandated by Sections 4a-60 and 4a-60a of the Connecticut General Statutes; and, when the awarding agency is the State, Sections 46a-71(d) and 46a-81i(d) of the Connecticut General Statutes. There are Contract Compliance Regulations codified at Section 46a-68j-21 through 43 of the Regulations of Connecticut State Agencies, which establish a procedure for awarding all contracts covered by Sections 4a-60 and 46a-71(d) of the Connecticut General Statutes.

According to Section 46a-68j-30(9) of the Contract Compliance Regulations, every agency awarding a contract subject to the contract compliance requirements has an obligation to "aggressively solicit the participation of legitimate minority business enterprises as bidders, contractors, subcontractors and suppliers of materials." "Minority business enterprise" is defined in Section 4a-60 of the Connecticut General Statutes as a business wherein fifty-one percent or more of the capital stock, or assets belong to a person or persons: "(1) Who are active in daily affairs of the enterprise; (2) who have the power to direct the management and policies of the enterprise; and (3) who are members of a minority, as such term is defined in subsection (a) of Section 32-9n." "Minority" groups are defined in Section 32-9n of the Connecticut General Statutes as "(1) Black Americans . . . (2) Hispanic Americans . . . (3) persons who have origins in the Iberian Peninsula . . . (4)Women . . . (5) Asian Pacific Americans and Pacific Islanders; (6) American Indians . . ." An individual with a disability is also a minority business enterprise as provided by Section 4a-60g of the Connecticut General Statutes. The above definitions apply to the contract compliance requirements by virtue of Section 46a-68j-21(11) of the Contract Compliance Regulations.

The awarding agency will consider the following factors when reviewing the bidder's qualifications under the contract compliance requirements:

(a) the bidder's success in implementing an affirmative action plan;
(b) the bidder's success in developing an apprenticeship program complying with Sections 46a-68-1 to 46a-68-17 of the Administrative Regulations of Connecticut State Agencies, inclusive;
(c) the bidder's promise to develop and implement a successful affirmative action plan;
(d) the bidder's submission of employment statistics contained in the "Employment Information Form", indicating that the composition of its workforce is at or near parity when compared to the racial and sexual composition of the workforce in the relevant labor market area; and
(e) the bidder's promise to set aside a portion of the contract for legitimate minority business enterprises. See Section 46a-68j-30(10)(E) of the Contract Compliance Regulations.

INSTRUCTIONS AND OTHER INFORMATION

The following BIDDER CONTRACT COMPLIANCE MONITORING REPORT must be completed in full, signed, and submitted with the bid for this contract. The contract awarding agency and the Commission on Human Rights and Opportunities will use the information contained thereon to determine the bidders compliance to Sections 4a-60 and 4a-60a CONN. GEN. STAT., and Sections 46a-68j-23 of the Regulations of Connecticut State Agencies regarding equal employment opportunity, and the bidder's good faith efforts to include minority business enterprises as subcontractors and suppliers for the work of the contract.

1) Definition of Small Contractor

Section 4a-60g CONN. GEN. STAT. defines a small contractor as a company that has been doing business under the same management and control and has maintained its principal place of business in Connecticut for a one year period immediately prior to its application for certification under this section, had gross revenues not exceeding fifteen million dollars in the most recently completed fiscal year, and at least fifty-one percent of the ownership of which is held by a person or persons who are active in the daily affairs of the company, and have the power to direct the management and policies of the company, except that a nonprofit corporation shall be construed to be a small contractor if such nonprofit corporation meets the requirements of subparagraphs (A) and (B) of subdivision 4a-60g CONN. GEN. STAT.

MANAGEMENT: Managers plan, organize, direct, and control the major functions of an organization through subordinates who are at the managerial or supervisory level. They make policy decisions and set objectives for the company or departments. They are not usually directly involved in production or providing services. Examples include top executives, public relations managers, managers of operations specialties (such as financial, human resources, or purchasing managers), and construction and engineering managers.

BUSINESS AND FINANCIAL OPERATIONS: These occupations include managers and professionals who work with the financial aspects of the business. These occupations include accountants and auditors, purchasing agents, management analysts, labor relations specialists, and budget, credit, and financial analysts.

MARKETING AND SALES: Occupations related to the act or process of buying and selling products and/or services such as sales engineer, retail sales workers and sales representatives including wholesale.

LEGAL OCCUPATIONS: In-House Counsel who is charged with providing legal advice and services in regards to legal issues that may arise during the course of standard business practices. This category also includes assistive legal occupations such as paralegals, legal assistants.

COMPUTER SPECIALISTS: Professionals responsible for the computer operations within a company are grouped in this category. Examples of job titles in this category include computer programmers, software engineers, database administrators, computer scientists,systems analysts, and computer support specialists

ARCHITECTURE AND ENGINEERING: Occupations related to architecture, surveying, engineering, and drafting are included in this category. Some of the job titles in this category include electrical and electronic engineers, surveyors, architects, drafters, mechanical engineers, materials engineers, mapping technicians, and civil engineers.

OFFICE AND ADMINISTRATIVE SUPPORT: All clerical-type work is included in this category. These jobs involve the preparing, transcribing, and preserving of written communications and records; collecting accounts; gathering and distributing information; operating office machines and electronic data processing equipment; and distributing mail. Job titles listed in this category include telephone operators, bill and account collectors, customer service representatives, dispatchers, secretaries and administrative assistants, computer operators and clerks (such as payroll, shipping, stock, mail and file).

BUILDING AND GROUNDS CLEANING AND MAINTENANCE: This category includes occupations involving landscaping, housekeeping, and janitorial services. Job titles found in this category include supervisors of landscaping or housekeeping, janitors, maids, grounds maintenance workers, and pest control workers.

CONSTRUCTION AND EXTRACTION: This category includes construction trades and related occupations. Job titles found in this category include boilermakers, masons (all types), carpenters, construction laborers, electricians, plumbers (and related trades), roofers, sheet metal workers, elevator installers, hazardous materials removal workers, paperhangers, and painters. Paving, surfacing, and tamping equipment operators; drywall and ceiling tile installers; and carpet, floor and tile installers and finishers are also included in this category. First line supervisors, foremen, and helpers in these trades are also grouped in this category..

INSTALLATION, MAINTENANCE AND REPAIR: Occupations involving the installation, maintenance, and repair of equipment are included in this group. Examples of job titles found here are heating, ac, and refrigeration mechanics and installers; telecommunication line installers and repairers; heavy vehicle and mobile equipment service technicians and mechanics; small engine mechanics; security and fire alarm systems installers; electric/electronic repair, industrial, utility and transportation equipment; millwrights; riggers; and manufactured building and mobile home installers. First line supervisors, foremen, and helpers for these jobs are also included in the category.

MATERIAL MOVING WORKERS: The job titles included in this group are Crane and tower operators; dredge, excavating, and lading machine operators; hoist and winch operators; industrial truck and tractor operators; cleaners of vehicles and equipment; laborers and freight, stock, and material movers, hand; machine feeders and offbearers; packers and packagers, hand; pumping station operators; refuse and recyclable material collectors; and miscellaneous material moving workers.

PRODUCTION WORKERS: The job titles included in this category are chemical production machine setters, operators and tenders; crushing/grinding workers; cutting workers; inspectors, testers sorters, samplers, weighers; precious stone/metal workers; painting workers; cementing/gluing machine operators and tenders; etchers/engravers; molders, shapers and casters except for metal and plastic; and production workers.

White (not of Hispanic Origin)- All persons having origins in any of the original peoples of Europe, North Africa, or the Middle East. Black(not of Hispanic Origin)- All persons having origins in any of the Black racial groups of Africa. Hispanic- All persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race.	Asian or Pacific Islander- All persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, or the Pacific Islands. This area includes China, India, Japan, Korea, the Philippine Islands, and Samoa. American Indian or Alaskan Native- All persons having origins in any of the original peoples of North America, and who maintain cultural identification through tribal affiliation or community recognition.

BIDDER CONTRACT COMPLIANCE MONITORING REPORT

PART I - Bidder Information

Company Name Street Address City & State Chief Executive	Bidder Federal Employer Identification Number _____ Or Social Security Number_____
Major Business Activity (brief description)	Bidder Identification (response optional/definitions on page 1) -Bidder is a small contractor. Yes __No __ -Bidder is a minority business enterprise Yes __No __ (If yes, check ownership category) Black ___ Hispanic___ Asian American___ American Indian/Alaskan Native ___Iberian Peninsula___ Individual(s) with a Physical Disability___ Female ___
Bidder Parent Company (If any)	- Bidder is certified as above by State of CT Yes__ No__
Other Locations in Ct. (If any)	

PART II - Bidder Nondiscrimination Policies and Procedures

1. Does your company have a written Affirmative Action/Equal Employment Opportunity statement posted on company bulletin boards? Yes__ No__	7. Do all of your company contracts and purchase orders contain non-discrimination statements as required by Sections 4a-60 & 4a-60a Conn. Gen. Stat.? Yes__ No__
2. Does your company have the state-mandated sexual harassment prevention in the workplace policy posted on company bulletin boards? Yes__ No__	8. Do you, upon request, provide reasonable accommodation to employees, or applicants for employment, who have physical or mental disability? Yes__ No__
3. Do you notify all recruitment sources in writing of your company's Affirmative Action/Equal Employment Opportunity employment policy? Yes__ No__	9. Does your company have a mandatory retirement age for all employees? Yes__ No__
4. Do your company advertisements contain a written statement that you are an Affirmative Action/Equal Opportunity Employer? Yes __No __	10. If your company has 50 or more employees, have you provided at least two (2) hours of sexual harassment training to all of your supervisors? Yes__ No__ NA__
5. Do you notify the Ct. State Employment Service of all employment openings with your company? Yes __No __	11. If your company has apprenticeship programs, do they meet the Affirmative Action/Equal Employment Opportunity requirements of the apprenticeship standards of the Ct. Dept. of Labor? Yes __No __NA __
6. Does your company have a collective bargaining agreement with workers? Yes__ No__ 6a. If yes, do the collective bargaining agreements contain non-discrim ination clauses covering all workers? Yes__ No__ 6b. Have you notified each union in writing of your commitments under the nondiscrimination requirements of contracts with the state of Ct? Yes__ No__	12. Does your company have a written affirmative action Plan? Yes __No __ If no, please explain. 13. Is there a person in your company who is responsible for equal employment opportunity? Yes __No __ If yes, give name and phone number. _____

Part III - Bidder Subcontracting Practices

1. Will the work of this contract include subcontractors or suppliers? Yes__ No__

1a. If yes, please list all subcontractors and suppliers and report if they are a small contractor and/or a minority business enterprise. (defined on page 1 / use additional sheet if necessary)

1b. Will the work of this contract require additional subcontractors or suppliers other than those identified in 1a. above? Yes__ No__

PART IV - Bidder Employment Information

Date:

JOB CATEGORY *	OVERALL TOTALS	WHITE (not of Hispanic origin)		BLACK (not of Hispanic origin)		HISPANIC		ASIAN or PACIFIC ISLANDER		AMERICAN INDIAN or ALASKAN NATIVE	
		Male	Female	Male	Female	Male	Female	Male	Female	male	female
Management											
Business & Financial Ops											
Marketing & Sales											
Legal Occupations											
Computer Specialists											
Architecture/Engineering											
Office & Admin Support											
Bldg/ Grounds Cleaning/Maintenance											
Construction & Extraction											
Installation , Maintenance & Repair											
Material Moving Workers											
Production Occupations											
TOTALS ABOVE											
Total One Year Ago											
FORMAL ON THE JOB TRAINEES (ENTER FIGURES FOR THE SAME CATEGORIES AS ARE SHOWN ABOVE)											
Apprentices											
Trainees											

*NOTE: JOB CATEGORIES CAN BE CHANGED OR ADDED TO (EX. SALES CAN BE ADDED OR REPLACE A CATEGORY NOT USED IN YOUR COMPANY)

1. Which of the following recruitment sources are used by you? (Check yes or no, and report percent used)				2. Check (X) any of the below listed requirements that you use as a hiring qualification		3. Describe below any other practices or actions that you take which show that you hire, train, and promote employees without discrimination
SOURCE	YES	NO	% of applicants provided by source	(X)		
State Employment Service					Work Experience	
Private Employment Agencies					Ability to Speak or Write English	
Schools and Colleges					Written Tests	
Newspaper Advertisement					High School Diploma	
Walk Ins					College Degree	
Present Employees					Union Membership	
Labor Organizations					Personal Recommendation	
Minority/Community Organizations					Height or Weight	
Others (please identify)					Car Ownership	
					Arrest Record	
					Wage Garnishments	

Certification (Read this form and check your statements on it CAREFULLY before signing). I certify that the statements made by me on this BIDDER CONTRACT COMPLIANCE MONITORING REPORT are complete and true to the best of my knowledge and belief, and are made in good faith. I understand that if I knowingly make any misstatements of facts, I am subject to be declared in non-compliance with Section 4a-60, 4a-60a, and related sections of the CONN. GEN. STAT.

(Signature)	(Title)	(Date Signed)	(Telephone)

DRAFT

AIA® Document A701® – 2018

Instructions to Bidders

for the following Project:
(Name, location, and detailed description)

« »
« »
« »

THE OWNER:
(Name, legal status, address, and other information)

« »« »
« »
« »
« »

THE ARCHITECT:
(Name, legal status, address, and other information)

« »« »
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TABLE OF ARTICLES

1 DEFINITIONS

2 BIDDER'S REPRESENTATIONS

3 BIDDING DOCUMENTS

4 BIDDING PROCEDURES

5 CONSIDERATION OF BIDS

6 POST-BID INFORMATION

7 PERFORMANCE BOND AND PAYMENT BOND

8 ENUMERATION OF THE PROPOSED CONTRACT DOCUMENTS

ADDITIONS AND DELETIONS: The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

FEDERAL, STATE, AND LOCAL LAWS MAY IMPOSE REQUIREMENTS ON PUBLIC PROCUREMENT CONTRACTS. CONSULT LOCAL AUTHORITIES OR AN ATTORNEY TO VERIFY REQUIREMENTS APPLICABLE TO THIS PROCUREMENT BEFORE COMPLETING THIS FORM.

It is intended that AIA Document G612™–2017, Owner's Instructions to the Architect, Parts A and B will be completed prior to using this document.

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ARTICLE 1 DEFINITIONS

§ 1.1 Bidding Documents include the Bidding Requirements and the Proposed Contract Documents. The Bidding Requirements consist of the advertisement or invitation to bid, Instructions to Bidders, supplementary instructions to bidders, the bid form, and any other bidding forms. The Proposed Contract Documents consist of the unexecuted form of Agreement between the Owner and Contractor and that Agreement's Exhibits, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, all Addenda, and all other documents enumerated in Article 8 of these Instructions.

§ 1.2 Definitions set forth in the General Conditions of the Contract for Construction, or in other Proposed Contract Documents apply to the Bidding Documents.

§ 1.3 Addenda are written or graphic instruments issued by the Architect, which, by additions, deletions, clarifications, or corrections, modify or interpret the Bidding Documents.

§ 1.4 A Bid is a complete and properly executed proposal to do the Work for the sums stipulated therein, submitted in accordance with the Bidding Documents.

§ 1.5 The Base Bid is the sum stated in the Bid for which the Bidder offers to perform the Work described in the Bidding Documents, to which Work may be added or deleted by sums stated in Alternate Bids.

§ 1.6 An Alternate Bid (or Alternate) is an amount stated in the Bid to be added to or deducted from, or that does not change, the Base Bid if the corresponding change in the Work, as described in the Bidding Documents, is accepted.

§ 1.7 A Unit Price is an amount stated in the Bid as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, as described in the Bidding Documents.

§ 1.8 A Bidder is a person or entity who submits a Bid and who meets the requirements set forth in the Bidding Documents.

§ 1.9 A Sub-bidder is a person or entity who submits a bid to a Bidder for materials, equipment, or labor for a portion of the Work.

ARTICLE 2 BIDDER'S REPRESENTATIONS

§ 2.1 By submitting a Bid, the Bidder represents that:

- **.1** the Bidder has read and understands the Bidding Documents;
- **.2** the Bidder understands how the Bidding Documents relate to other portions of the Project, if any, being bid concurrently or presently under construction;
- **.3** the Bid complies with the Bidding Documents;
- **.4** the Bidder has visited the site, become familiar with local conditions under which the Work is to be performed, and has correlated the Bidder's observations with the requirements of the Proposed Contract Documents;
- **.5** the Bid is based upon the materials, equipment, and systems required by the Bidding Documents without exception; and
- **.6** the Bidder has read and understands the provisions for liquidated damages, if any, set forth in the form of Agreement between the Owner and Contractor.

ARTICLE 3 BIDDING DOCUMENTS

§ 3.1 Distribution

§ 3.1.1 Bidders shall obtain complete Bidding Documents, as indicated below, from the issuing office designated in the advertisement or invitation to bid, for the deposit sum, if any, stated therein.
(Indicate how, such as by email, website, host site/platform, paper copy, or other method Bidders shall obtain Bidding Documents.)

« »

§ 3.1.2 Any required deposit shall be refunded to Bidders who submit a bona fide Bid and return the paper Bidding Documents in good condition within ten days after receipt of Bids. The cost to replace missing or damaged paper

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documents will be deducted from the deposit. A Bidder receiving a Contract award may retain the paper Bidding Documents, and the Bidder's deposit will be refunded.

§ 3.1.3 Bidding Documents will not be issued directly to Sub-bidders unless specifically offered in the advertisement or invitation to bid, or in supplementary instructions to bidders.

§ 3.1.4 Bidders shall use complete Bidding Documents in preparing Bids. Neither the Owner nor Architect assumes responsibility for errors or misinterpretations resulting from the use of incomplete Bidding Documents.

§ 3.1.5 The Bidding Documents will be available for the sole purpose of obtaining Bids on the Work. No license or grant of use is conferred by distribution of the Bidding Documents.

§ 3.2 Modification or Interpretation of Bidding Documents

§ 3.2.1 The Bidder shall carefully study the Bidding Documents, shall examine the site and local conditions, and shall notify the Architect of errors, inconsistencies, or ambiguities discovered and request clarification or interpretation pursuant to Section 3.2.2.

§ 3.2.2 Requests for clarification or interpretation of the Bidding Documents shall be submitted by the Bidder in writing and shall be received by the Architect at least seven days prior to the date for receipt of Bids.
(Indicate how, such as by email, website, host site/platform, paper copy, or other method Bidders shall submit requests for clarification and interpretation.)

« »

§ 3.2.3 Modifications and interpretations of the Bidding Documents shall be made by Addendum. Modifications and interpretations of the Bidding Documents made in any other manner shall not be binding, and Bidders shall not rely upon them.

§ 3.3 Substitutions

§ 3.3.1 The materials, products, and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance, and quality to be met by any proposed substitution.

§ 3.3.2 Substitution Process

§ 3.3.2.1 Written requests for substitutions shall be received by the Architect at least ten days prior to the date for receipt of Bids. Requests shall be submitted in the same manner as that established for submitting clarifications and interpretations in Section 3.2.2.

§ 3.3.2.2 Bidders shall submit substitution requests on a Substitution Request Form if one is provided in the Bidding Documents.

§ 3.3.2.3 If a Substitution Request Form is not provided, requests shall include (1) the name of the material or equipment specified in the Bidding Documents; (2) the reason for the requested substitution; (3) a complete description of the proposed substitution including the name of the material or equipment proposed as the substitute, performance and test data, and relevant drawings; and (4) any other information necessary for an evaluation. The request shall include a statement setting forth changes in other materials, equipment, or other portions of the Work, including changes in the work of other contracts or the impact on any Project Certifications (such as LEED), that will result from incorporation of the proposed substitution.

§ 3.3.3 The burden of proof of the merit of the proposed substitution is upon the proposer. The Architect's decision of approval or disapproval of a proposed substitution shall be final.

§ 3.3.4 If the Architect approves a proposed substitution prior to receipt of Bids, such approval shall be set forth in an Addendum. Approvals made in any other manner shall not be binding, and Bidders shall not rely upon them.

§ 3.3.5 No substitutions will be considered after the Contract award unless specifically provided for in the Contract Documents.

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§ 3.4 Addenda

§ 3.4.1 Addenda will be transmitted to Bidders known by the issuing office to have received complete Bidding Documents.

(Indicate how, such as by email, website, host site/platform, paper copy, or other method Addenda will be transmitted.)

« »

§ 3.4.2 Addenda will be available where Bidding Documents are on file.

§ 3.4.3 Addenda will be issued no later than four days prior to the date for receipt of Bids, except an Addendum withdrawing the request for Bids or one which includes postponement of the date for receipt of Bids.

§ 3.4.4 Prior to submitting a Bid, each Bidder shall ascertain that the Bidder has received all Addenda issued, and the Bidder shall acknowledge their receipt in the Bid.

ARTICLE 4 BIDDING PROCEDURES

§ 4.1 Preparation of Bids

§ 4.1.1 Bids shall be submitted on the forms included with or identified in the Bidding Documents.

§ 4.1.2 All blanks on the bid form shall be legibly executed. Paper bid forms shall be executed in a non-erasable medium.

§ 4.1.3 Sums shall be expressed in both words and numbers, unless noted otherwise on the bid form. In case of discrepancy, the amount entered in words shall govern.

§ 4.1.4 Edits to entries made on paper bid forms must be initialed by the signer of the Bid.

§ 4.1.5 All requested Alternates shall be bid. If no change in the Base Bid is required, enter "No Change" or as required by the bid form.

§ 4.1.6 Where two or more Bids for designated portions of the Work have been requested, the Bidder may, without forfeiture of the bid security, state the Bidder's refusal to accept award of less than the combination of Bids stipulated by the Bidder. The Bidder shall neither make additional stipulations on the bid form nor qualify the Bid in any other manner.

§ 4.1.7 Each copy of the Bid shall state the legal name and legal status of the Bidder. As part of the documentation submitted with the Bid, the Bidder shall provide evidence of its legal authority to perform the Work in the jurisdiction where the Project is located. Each copy of the Bid shall be signed by the person or persons legally authorized to bind the Bidder to a contract. A Bid by a corporation shall further name the state of incorporation and have the corporate seal affixed. A Bid submitted by an agent shall have a current power of attorney attached, certifying the agent's authority to bind the Bidder.

§ 4.1.8 A Bidder shall incur all costs associated with the preparation of its Bid.

§ 4.2 Bid Security

§ 4.2.1 Each Bid shall be accompanied by the following bid security:

(Insert the form and amount of bid security.)

« »

§ 4.2.2 The Bidder pledges to enter into a Contract with the Owner on the terms stated in the Bid and shall, if required, furnish bonds covering the faithful performance of the Contract and payment of all obligations arising thereunder. Should the Bidder refuse to enter into such Contract or fail to furnish such bonds if required, the amount of the bid security shall be forfeited to the Owner as liquidated damages, not as a penalty. In the event the Owner fails to comply with Section 6.2, the amount of the bid security shall not be forfeited to the Owner.

§ 4.2.3 If a surety bond is required as bid security, it shall be written on AIA Document A310™, Bid Bond, unless otherwise provided in the Bidding Documents. The attorney-in-fact who executes the bond on behalf of the surety shall

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affix to the bond a certified and current copy of an acceptable power of attorney. The Bidder shall provide surety bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 4.2.4 The Owner will have the right to retain the bid security of Bidders to whom an award is being considered until (a) the Contract has been executed and bonds, if required, have been furnished; (b) the specified time has elapsed so that Bids may be withdrawn; or (c) all Bids have been rejected. However, if no Contract has been awarded or a Bidder has not been notified of the acceptance of its Bid, a Bidder may, beginning« »days after the opening of Bids, withdraw its Bid and request the return of its bid security.

§ 4.3 Submission of Bids

§ 4.3.1 A Bidder shall submit its Bid as indicated below:
(Indicate how, such as by website, host site/platform, paper copy, or other method Bidders shall submit their Bid.)

« »

§ 4.3.2 Paper copies of the Bid, the bid security, and any other documents required to be submitted with the Bid shall be enclosed in a sealed opaque envelope. The envelope shall be addressed to the party receiving the Bids and shall be identified with the Project name, the Bidder's name and address, and, if applicable, the designated portion of the Work for which the Bid is submitted. If the Bid is sent by mail, the sealed envelope shall be enclosed in a separate mailing envelope with the notation "SEALED BID ENCLOSED" on the face thereof.

§ 4.3.3 Bids shall be submitted by the date and time and at the place indicated in the invitation to bid. Bids submitted after the date and time for receipt of Bids, or at an incorrect place, will not be accepted.

§ 4.3.4 The Bidder shall assume full responsibility for timely delivery at the location designated for receipt of Bids.

§ 4.3.5 A Bid submitted by any method other than as provided in this Section 4.3 will not be accepted.

§ 4.4 Modification or Withdrawal of Bid

§ 4.4.1 Prior to the date and time designated for receipt of Bids, a Bidder may submit a new Bid to replace a Bid previously submitted, or withdraw its Bid entirely, by notice to the party designated to receive the Bids. Such notice shall be received and duly recorded by the receiving party on or before the date and time set for receipt of Bids. The receiving party shall verify that replaced or withdrawn Bids are removed from the other submitted Bids and not considered. Notice of submission of a replacement Bid or withdrawal of a Bid shall be worded so as not to reveal the amount of the original Bid.

§ 4.4.2 Withdrawn Bids may be resubmitted up to the date and time designated for the receipt of Bids in the same format as that established in Section 4.3, provided they fully conform with these Instructions to Bidders. Bid security shall be in an amount sufficient for the Bid as resubmitted.

§ 4.4.3 After the date and time designated for receipt of Bids, a Bidder who discovers that it made a clerical error in its Bid shall notify the Architect of such error within two days, or pursuant to a timeframe specified by the law of the jurisdiction where the Project is located, requesting withdrawal of its Bid. Upon providing evidence of such error to the reasonable satisfaction of the Architect, the Bid shall be withdrawn and not resubmitted. If a Bid is withdrawn pursuant to this Section 4.4.3, the bid security will be attended to as follows:
(State the terms and conditions, such as Bid rank, for returning or retaining the bid security.)

« »

ARTICLE 5 CONSIDERATION OF BIDS

§ 5.1 Opening of Bids

If stipulated in an advertisement or invitation to bid, or when otherwise required by law, Bids properly identified and received within the specified time limits will be publicly opened and read aloud. A summary of the Bids may be made available to Bidders.

§ 5.2 Rejection of Bids

Unless otherwise prohibited by law, the Owner shall have the right to reject any or all Bids.

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§ 5.3 Acceptance of Bid (Award)

§ 5.3.1 It is the intent of the Owner to award a Contract to the lowest responsive and responsible Bidder, provided the Bid has been submitted in accordance with the requirements of the Bidding Documents. Unless otherwise prohibited by law, the Owner shall have the right to waive informalities and irregularities in a Bid received and to accept the Bid which, in the Owner's judgment, is in the Owner's best interests.

§ 5.3.2 Unless otherwise prohibited by law, the Owner shall have the right to accept Alternates in any order or combination, unless otherwise specifically provided in the Bidding Documents, and to determine the lowest responsive and responsible Bidder on the basis of the sum of the Base Bid and Alternates accepted.

ARTICLE 6 POST-BID INFORMATION

§ 6.1 Contractor's Qualification Statement

Bidders to whom award of a Contract is under consideration shall submit to the Architect, upon request and within the timeframe specified by the Architect, a properly executed AIA Document A305™, Contractor's Qualification Statement, unless such a Statement has been previously required and submitted for this Bid.

§ 6.2 Owner's Financial Capability

A Bidder to whom award of a Contract is under consideration may request in writing, fourteen days prior to the expiration of the time for withdrawal of Bids, that the Owner furnish to the Bidder reasonable evidence that financial arrangements have been made to fulfill the Owner's obligations under the Contract. The Owner shall then furnish such reasonable evidence to the Bidder no later than seven days prior to the expiration of the time for withdrawal of Bids. Unless such reasonable evidence is furnished within the allotted time, the Bidder will not be required to execute the Agreement between the Owner and Contractor.

§ 6.3 Submittals

§ 6.3.1 After notification of selection for the award of the Contract, the Bidder shall, as soon as practicable or as stipulated in the Bidding Documents, submit in writing to the Owner through the Architect:

- **.1** a designation of the Work to be performed with the Bidder's own forces;
- **.2** names of the principal products and systems proposed for the Work and the manufacturers and suppliers of each; and
- **.3** names of persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for the principal portions of the Work.

§ 6.3.2 The Bidder will be required to establish to the satisfaction of the Architect and Owner the reliability and responsibility of the persons or entities proposed to furnish and perform the Work described in the Bidding Documents.

§ 6.3.3 Prior to the execution of the Contract, the Architect will notify the Bidder if either the Owner or Architect, after due investigation, has reasonable objection to a person or entity proposed by the Bidder. If the Owner or Architect has reasonable objection to a proposed person or entity, the Bidder may, at the Bidder's option, withdraw the Bid or submit an acceptable substitute person or entity. The Bidder may also submit any required adjustment in the Base Bid or Alternate Bid to account for the difference in cost occasioned by such substitution. The Owner may accept the adjusted bid price or disqualify the Bidder. In the event of either withdrawal or disqualification, bid security will not be forfeited.

§ 6.3.4 Persons and entities proposed by the Bidder and to whom the Owner and Architect have made no reasonable objection must be used on the Work for which they were proposed and shall not be changed except with the written consent of the Owner and Architect.

ARTICLE 7 PERFORMANCE BOND AND PAYMENT BOND

§ 7.1 Bond Requirements

§ 7.1.1 If stipulated in the Bidding Documents, the Bidder shall furnish bonds covering the faithful performance of the Contract and payment of all obligations arising thereunder.

§ 7.1.2 If the furnishing of such bonds is stipulated in the Bidding Documents, the cost shall be included in the Bid. If the furnishing of such bonds is required after receipt of bids and before execution of the Contract, the cost of such bonds shall be added to the Bid in determining the Contract Sum.

§ 7.1.3 The Bidder shall provide surety bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

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§ 7.1.4 Unless otherwise indicated below, the Penal Sum of the Payment and Performance Bonds shall be the amount of the Contract Sum.
(If Payment or Performance Bonds are to be in an amount other than 100% of the Contract Sum, indicate the dollar amount or percentage of the Contract Sum.)

« »

§ 7.2 Time of Delivery and Form of Bonds
§ 7.2.1 The Bidder shall deliver the required bonds to the Owner not later than three days following the date of execution of the Contract. If the Work is to commence sooner in response to a letter of intent, the Bidder shall, prior to commencement of the Work, submit evidence satisfactory to the Owner that such bonds will be furnished and delivered in accordance with this Section 7.2.1.

§ 7.2.2 Unless otherwise provided, the bonds shall be written on AIA Document A312, Performance Bond and Payment Bond.

§ 7.2.3 The bonds shall be dated on or after the date of the Contract.

§ 7.2.4 The Bidder shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix to the bond a certified and current copy of the power of attorney.

ARTICLE 8 ENUMERATION OF THE PROPOSED CONTRACT DOCUMENTS
§ 8.1 Copies of the proposed Contract Documents have been made available to the Bidder and consist of the following documents:

.1 AIA Document A101™–2017, Standard Form of Agreement Between Owner and Contractor, unless otherwise stated below.
(Insert the complete AIA Document number, including year, and Document title.)

« »

.2 AIA Document A101™–2017, Exhibit A, Insurance and Bonds, unless otherwise stated below.
(Insert the complete AIA Document number, including year, and Document title.)

« »

.3 AIA Document A201™–2017, General Conditions of the Contract for Construction, unless otherwise stated below.
(Insert the complete AIA Document number, including year, and Document title.)

« »

.4 AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, dated as indicated below:
(Insert the date of the E203-2013.)

« »

.5 Drawings

Number	Title	Date

.6 Specifications

Section	Title	Date	Pages

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.7 Addenda:

Number	Date	Pages

.8 Other Exhibits:
(Check all boxes that apply and include appropriate information identifying the exhibit where required.)

[« »] AIA Document E204™–2017, Sustainable Projects Exhibit, dated as indicated below:
(Insert the date of the E204-2017.)

« »

[« »] The Sustainability Plan:

Title	Date	Pages

[« »] Supplementary and other Conditions of the Contract:

Document	Title	Date	Pages

.9 Other documents listed below:
(List here any additional documents that are intended to form part of the Proposed Contract Documents.)

« »

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PART 1 - GENERAL

1.1 RESPONSIBILITY FOR MEASUREMENT OF QUANTITIES

A. The Contractor shall have sole responsibility for the accuracy of all measurements and for estimating the material quantities required to satisfy these specifications.

1.2 DISCREPANCIES AND ADDENDA

A. Should a Bidder find any discrepancies in the Drawings and Specifications, or should they be in doubt as to their meaning, they shall notify the Owner at once, who will send a written Addendum to all Bidders concerned. Oral instructions or decisions, unless confirmed by Addenda, will not be considered valid, legal, or binding. No change order requests will be authorized or considered because of the failure of the Contractor to include work called for in the Addenda in their bid.

1.3 MODIFICATIONS TO AIA DOCUMENT A701, Instructions to Bidders, 2018.

The following sections modify the provisions and procedures to the degree listed in the sections and articles listed in these supplementary instructions.

ARTICLE 3 **Make the following changes:**

3.1.1 **Delete** all but the first sentence and ", as indicated below," from the first sentence.

3.1.2 **Delete** in its entirety.

3.2.2 **Delete** all but the first sentence, delete "at least seven days prior to the date for receipt of Bids" and insert "by date stipulated in General Instructions to Bidders".

3.3.2.1 **Delete** all but the first sentence.

3.4.1 **Delete** all but the first sentence.

3.4.3 **Delete the phrase** "four days prior to the date for receipt" and insert "24 hours prior to the date and time for receipt".

ARTICLE 4 **Make the following changes:**

4.2.1 **Revise to read as follows:** "Each Bid shall be accompanied by the bid security as indicated on the Invitation to Bid."

4.2.4 **Revise last sentence to read as follows:** "However, if no Contract has been awarded or a Bidder has not been notified of the acceptance of its Bid, a Bidder may withdraw its Bid and request the return of its bid security after the length of time on the Invitation to Bid."

4.3.1 **Add to the end the following:** "Paper copy".

4.4.3 **Add to the end the following:** "Owner will return bid security to the Bidder."

ARTICLE 5 **Add the following:**

5.3.3 Contractors who have paid liquidated damages or penalties to an Owner for failing to comply with the schedule of any project in the last five (5) years are disqualified from this project, subject to an appeal to the Owner's Representative(s) where the Contractor demonstrates

that 1) subsequent to the project which resulted in penalties the Contractor completed two (2) similar projects or demonstrably similar projects in a timely fashion; and 2) that the factors which lead to delays and penalties in the first instance no longer exist. Payment of liquidated damages or penalties may also be defined as "having been found by the Owner to be in non-compliance with the project schedule and negotiating a financial settlement for the project in which value was returned to the Owner, either via change orders or 'work-in-kind' or other recognized manner". The Contractor under consideration shall respond to this clause in the Statement of Qualifications, as provided herein.

ARTICLE 6 **Add the following:**

6.1.1 The Owner will make investigations as he deems necessary to determine the ability of the Bidder to perform the Work, and the Bidder shall furnish the Owner all such information and data for this purpose as the Owner may request.

6.4 Work Phasing Schedule

Bidders to whom award of the Contractor is under consideration shall submit to the Architect within fifteen (15) days of the Contract date, a detailed work Phasing Schedule describing the bodies of work to be undertaken and areas of the project to be addressed in per week periods between the Award of the Contract and the Bidder's proposed date of Substantial Completion.

ARTICLE 7 **Add the following:**

7.3 The Contractor and the Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.

7.4 If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except to participate in conferences as provided in Subparagraph 7.5.1.

7.5 If there is no Owner Default, the Surety's obligation under this Bond shall arise after:

7.5.1 The Owner has notified the Contractor and the Surety at its address described in Paragraph 7.12 below that the Owner is considering declaring a Contractor Default and has requested and attempted to arrange a conference with the Contractor and the Surety to be held not later than fifteen (15) days after receipt of such notice to discuss methods of performing the Construction Contract. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement shall not waive the Owner's right, if any, subsequently to declare a Contractor Default and

7.5.2 The Owner has declared a Contractor Default and formally terminated the Contractor's right to complete the contract. Such Contractor Default shall not be declared earlier than twenty (20) days after the Contractor and the Surety have received notice as provided in Subparagraph 7.5.1; and

7.5.3 The Owner has agreed to pay the Balance of the Contract Price to the Surety in accordance with the terms of the Construction Contract or to a contractor selected to perform the Construction Contract in accordance with the terms of the contract with the Owner.

7.6 When the Owner has satisfied the conditions of Paragraph 7.5.3, the Surety shall promptly and at the Surety's expense take one of the following actions:

7.6.1 Arrange for the Contractor, with consent of the Owner, to perform and complete the Construction Contract; or

7.6.2 Undertake to perform and complete the Construction Contract itself, through its agents or through independent contractors; or

7.6.3 Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and the contractor selected with the Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages (as described in Paragraph 7.8) in excess of the Balance of the Contract Price incurred by the Owner resulting from the Contractor's default: or

7.6.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances:

.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, tender payment therefore to the Owner; or

.2 Deny liability in whole or in part and notify the Owner citing reasons therefore.

7.7 If the Surety does not proceed as provided in Paragraph 7.6 with reasonable promptness, the Surety shall be deemed to be in default on this Bond fifteen (15) days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Subparagraph 7.6.4, and the Owner refuses the payment rendered or the Surety has denied liability, in whole or in part, without further notice the Owner shall be entitled to enforce any remedy available to the Owner.

7.8 After the Owner has terminated the Contractor's right to complete the Construction Contract, and if the Surety elects to act under Subparagraph 7.6.1, 7.6.2, or 7.6.3 above, then the responsibilities of the Surety to the Owner shall not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety shall not be greater than those of the Owner under the Construction Contract. To the limit of the amount of this Bond, but subject to commitment by the Owner of the Balance of the Contract Price to mitigation of costs and damages on the Construction Contract, the Surety is obligated without duplication for:

7.8.1 The responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;

7.8.2 Additional legal, design professional and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 7.6; and

7.8.3 Late delivery penalties or if penalties are not specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

7.9 The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, or successors.

7.10 The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

7.11 Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and shall be instituted within two (2) years after Contractor Default or within two (2) years after the Contractor ceased working or within two (2) years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

7.12 Notice to the Surety, the Owner or the Contractor shall be mailed or delivered to the address shown on the signature page.

7.13 When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common-law bond.

7.14 Definitions.

7.14.1 Balance of the Contract Price: The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made, including allowance to the Contractor of any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

7.14.2 Construction Contract: The agreement between the Owner and the Contractor identified on the signature page, including all Contract Documents and changes thereto.

7.14.3 Contractor Default: Failure of the Contractor, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Construction Contract.

7.14.4 Owner Default: Failure of the Owner, which has neither been remedied nor waived, to pay the Contractor as required by the Construction Contract or to perform and complete or comply with the other terms thereof.

ARTICLE 8 Make the following changes:

Delete in its entirety.

Add the following Articles:

ARTICLE 9 MISCELLANEOUS REQUIREMENTS

9.1 Watchman

The employment of continuous watchman service to guard the property during any and all hours shall be at the discretion of the Contractor. However, the Contractor shall remove and restore all work or temporary structures damaged by fire, vandalism, or similar acts at no extra cost to the Owner.

9.2 Overtime

The Contractor must include within their base price all overtime, nights, holidays, and weekends as required to meet the Project Completion date.

9.3 Permits
The Contractor must obtain their own town and building permits at no additional charge to the Owner. Town of Trumbull permits can be obtained from the Town of Trumbull at NO cost to the Contractor, excluding the State Education permit cost of $0.26/$1,000 value.

9.4 Supervision
The Contractor must provide full-time, properly qualified on-site supervision for the entire duration of the project, while workpersons are on site.

9.5 Department of Administrative Services (DAS)
In accordance with Connecticut General Statute Secs. 4a-100 and 4b-91, a responsible bid that exceeds $500,000 for this vertical building project must contain two (2) documents: **The Contractor Prequalification Certificate and the Update (Bid) Statement.** These two (2) documents must be submitted with the bid form. Contact the DAS Contractor Prequalification Unit at 860-713-5280 for more information. The classification GENERAL BUILDING CONSTRUCTION (GROUP B) is required as a minimum.

9.6 Commission on Human Rights and Opportunities (CHRO)
The Contractor who is selected to perform this State project must comply with CT General Statutes 4a-60, 4a-60a, 4a-60g, and 46a-68b through 46a-68f, inclusive, as amended by June 2015 Special Session Public Act 15-5.

State law requires a minimum of twenty-five (25%) percent of the state-funded portion of the contract be set aside for award to subcontractors holding current certification from the Connecticut Department of Administrative Services (DAS) under the provisions of CT General Statute 4a-60g. **(Twenty-five percent (25%) of the total state-funded value with DAS-certified Small Businesses and six and one-quarter percent (6.25%) of the total state-funded value with DAS-certified Minority-, Women- and/or Disabled-Owned Businesses.)** The Contractor must demonstrate good faith effort to meet the twenty-five percent (25%) set-aside goals.

9.7 Public Health Emergency
The Contractor shall anticipate and incorporate in their Bid all potential costs related to a public health emergency such as the COVID-19/Coronavirus Pandemic, including rules, regulations, and recommendations issued by public authorities. The potential costs may include, but are not limited to, costs related to social distancing, manpower levels, project scheduling, construction coordination, material/product supplies and delivery delays, material escalation costs, increased subcontractor/supplier costs, loss of productivity and inefficiency costs, extended general conditions costs, and any other potential costs.

ARTICLE 10 BIDDERS REPRESENTATION
Each bidder shall fully acquaint himself with conditions as they exist, so that he fully understands the complexities and restrictions attending the execution of the Work included in the Bid Documents. The failure to receive or examine any form, instrument, or document, or to visit the site to become acquainted with field conditions, shall in no way relieve the Bidder from any obligation with respect to the Bidder's proposal.

END OF SECTION

DRAFT

AIA® Document A101® – 2017

Standard Form of Agreement Between Owner and Contractor

where the basis of payment is a Stipulated Sum

AGREEMENT made as of the « » day of « » in the year « »
(In words, indicate day, month and year.)

BETWEEN the Owner:
(Name, legal status, address and other information)

« »« »
« »
« »
« »

and the Contractor:
(Name, legal status, address and other information)

« »« »
« »
« »
« »

for the following Project:
(Name, location and detailed description)

« »
« »
« »

The Architect:
(Name, legal status, address and other information)

« »« »
« »
« »
« »

The Owner and Contractor agree as follows.

ADDITIONS AND DELETIONS: The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

The parties should complete A101®–2017, Exhibit A, Insurance and Bonds, contemporaneously with this Agreement. AIA Document A201®–2017, General Conditions of the Contract for Construction, is adopted in this document by reference. Do not use with other general conditions unless this document is modified.

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TABLE OF ARTICLES

1 THE CONTRACT DOCUMENTS

2 THE WORK OF THIS CONTRACT

3 DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION

4 CONTRACT SUM

5 PAYMENTS

6 DISPUTE RESOLUTION

7 TERMINATION OR SUSPENSION

8 MISCELLANEOUS PROVISIONS

9 ENUMERATION OF CONTRACT DOCUMENTS

EXHIBIT A INSURANCE AND BONDS

ARTICLE 1 THE CONTRACT DOCUMENTS

The Contract Documents consist of this Agreement, Conditions of the Contract (General, Supplementary, and other Conditions), Drawings, Specifications, Addenda issued prior to execution of this Agreement, other documents listed in this Agreement, and Modifications issued after execution of this Agreement, all of which form the Contract, and are as fully a part of the Contract as if attached to this Agreement or repeated herein. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. An enumeration of the Contract Documents, other than a Modification, appears in Article 9.

ARTICLE 2 THE WORK OF THIS CONTRACT

The Contractor shall fully execute the Work described in the Contract Documents, except as specifically indicated in the Contract Documents to be the responsibility of others.

ARTICLE 3 DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION

§ 3.1 The date of commencement of the Work shall be:
(Check one of the following boxes.)

[« »] The date of this Agreement.

[« »] A date set forth in a notice to proceed issued by the Owner.

[« »] Established as follows:
(Insert a date or a means to determine the date of commencement of the Work.)

« »

If a date of commencement of the Work is not selected, then the date of commencement shall be the date of this Agreement.

§ 3.2 The Contract Time shall be measured from the date of commencement of the Work.

§ 3.3 Substantial Completion

§ 3.3.1 Subject to adjustments of the Contract Time as provided in the Contract Documents, the Contractor shall achieve Substantial Completion of the entire Work:
(Check one of the following boxes and complete the necessary information.)

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[« »] Not later than « » (« ») calendar days from the date of commencement of the Work.

[« »] By the following date: « »

§ 3.3.2 Subject to adjustments of the Contract Time as provided in the Contract Documents, if portions of the Work are to be completed prior to Substantial Completion of the entire Work, the Contractor shall achieve Substantial Completion of such portions by the following dates:

Portion of Work	Substantial Completion Date

§ 3.3.3 If the Contractor fails to achieve Substantial Completion as provided in this Section 3.3, liquidated damages, if any, shall be assessed as set forth in Section 4.5.

ARTICLE 4 CONTRACT SUM

§ 4.1 The Owner shall pay the Contractor the Contract Sum in current funds for the Contractor's performance of the Contract. The Contract Sum shall be « » ($ « »), subject to additions and deductions as provided in the Contract Documents.

§ 4.2 Alternates

§ 4.2.1 Alternates, if any, included in the Contract Sum:

Item	Price

§ 4.2.2 Subject to the conditions noted below, the following alternates may be accepted by the Owner following execution of this Agreement. Upon acceptance, the Owner shall issue a Modification to this Agreement.
(Insert below each alternate and the conditions that must be met for the Owner to accept the alternate.)

Item	Price	Conditions for Acceptance

§ 4.3 Allowances, if any, included in the Contract Sum:
(Identify each allowance.)

Item	Price

§ 4.4 Unit prices, if any:
(Identify the item and state the unit price and quantity limitations, if any, to which the unit price will be applicable.)

Item	Units and Limitations	Price per Unit ($0.00)

§ 4.5 Liquidated damages, if any:
(Insert terms and conditions for liquidated damages, if any.)

« »

§ 4.6 Other:
(Insert provisions for bonus or other incentives, if any, that might result in a change to the Contract Sum.)

« »

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ARTICLE 5 PAYMENTS

§ 5.1 Progress Payments

§ 5.1.1 Based upon Applications for Payment submitted to the Architect by the Contractor and Certificates for Payment issued by the Architect, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents.

§ 5.1.2 The period covered by each Application for Payment shall be one calendar month ending on the last day of the month, or as follows:

« »

§ 5.1.3 Provided that an Application for Payment is received by the Architect not later than the « » day of a month, the Owner shall make payment of the amount certified to the Contractor not later than the « » day of the « » month. If an Application for Payment is received by the Architect after the application date fixed above, payment of the amount certified shall be made by the Owner not later than « » (« ») days after the Architect receives the Application for Payment.
(Federal, state or local laws may require payment within a certain period of time.)

§ 5.1.4 Each Application for Payment shall be based on the most recent schedule of values submitted by the Contractor in accordance with the Contract Documents. The schedule of values shall allocate the entire Contract Sum among the various portions of the Work. The schedule of values shall be prepared in such form, and supported by such data to substantiate its accuracy, as the Architect may require. This schedule of values shall be used as a basis for reviewing the Contractor's Applications for Payment.

§ 5.1.5 Applications for Payment shall show the percentage of completion of each portion of the Work as of the end of the period covered by the Application for Payment.

§ 5.1.6 In accordance with AIA Document A201™–2017, General Conditions of the Contract for Construction, and subject to other provisions of the Contract Documents, the amount of each progress payment shall be computed as follows:

§ 5.1.6.1 The amount of each progress payment shall first include:

- **.1** That portion of the Contract Sum properly allocable to completed Work;
- **.2** That portion of the Contract Sum properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the completed construction, or, if approved in advance by the Owner, suitably stored off the site at a location agreed upon in writing; and
- **.3** That portion of Construction Change Directives that the Architect determines, in the Architect's professional judgment, to be reasonably justified.

§ 5.1.6.2 The amount of each progress payment shall then be reduced by:

- **.1** The aggregate of any amounts previously paid by the Owner;
- **.2** The amount, if any, for Work that remains uncorrected and for which the Architect has previously withheld a Certificate for Payment as provided in Article 9 of AIA Document A201–2017;
- **.3** Any amount for which the Contractor does not intend to pay a Subcontractor or material supplier, unless the Work has been performed by others the Contractor intends to pay;
- **.4** For Work performed or defects discovered since the last payment application, any amount for which the Architect may withhold payment, or nullify a Certificate of Payment in whole or in part, as provided in Article 9 of AIA Document A201–2017; and
- **.5** Retainage withheld pursuant to Section 5.1.7.

§ 5.1.7 Retainage

§ 5.1.7.1 For each progress payment made prior to Substantial Completion of the Work, the Owner may withhold the following amount, as retainage, from the payment otherwise due:
(Insert a percentage or amount to be withheld as retainage from each Application for Payment. The amount of retainage may be limited by governing law.)

« »

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§ 5.1.7.1.1 The following items are not subject to retainage:
(Insert any items not subject to the withholding of retainage, such as general conditions, insurance, etc.)

« »

§ 5.1.7.2 Reduction or limitation of retainage, if any, shall be as follows:
(If the retainage established in Section 5.1.7.1 is to be modified prior to Substantial Completion of the entire Work, including modifications for Substantial Completion of portions of the Work as provided in Section 3.3.2, insert provisions for such modifications.)

« »

§ 5.1.7.3 Except as set forth in this Section 5.1.7.3, upon Substantial Completion of the Work, the Contractor may submit an Application for Payment that includes the retainage withheld from prior Applications for Payment pursuant to this Section 5.1.7. The Application for Payment submitted at Substantial Completion shall not include retainage as follows:
(Insert any other conditions for release of retainage upon Substantial Completion.)

« »

§ 5.1.8 If final completion of the Work is materially delayed through no fault of the Contractor, the Owner shall pay the Contractor any additional amounts in accordance with Article 9 of AIA Document A201–2017.

§ 5.1.9 Except with the Owner's prior approval, the Contractor shall not make advance payments to suppliers for materials or equipment which have not been delivered and stored at the site.

§ 5.2 Final Payment

§ 5.2.1 Final payment, constituting the entire unpaid balance of the Contract Sum, shall be made by the Owner to the Contractor when

.1 the Contractor has fully performed the Contract except for the Contractor's responsibility to correct Work as provided in Article 12 of AIA Document A201–2017, and to satisfy other requirements, if any, which extend beyond final payment; and

.2 a final Certificate for Payment has been issued by the Architect.

§ 5.2.2 The Owner's final payment to the Contractor shall be made no later than 30 days after the issuance of the Architect's final Certificate for Payment, or as follows:

« »

§ 5.3 Interest

Payments due and unpaid under the Contract shall bear interest from the date payment is due at the rate stated below, or in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.
(Insert rate of interest agreed upon, if any.)

« » % « »

ARTICLE 6 DISPUTE RESOLUTION

§ 6.1 Initial Decision Maker

The Architect will serve as the Initial Decision Maker pursuant to Article 15 of AIA Document A201–2017, unless the parties appoint below another individual, not a party to this Agreement, to serve as the Initial Decision Maker.
(If the parties mutually agree, insert the name, address and other contact information of the Initial Decision Maker, if other than the Architect.)

« »
« »
« »
« »

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§ 6.2 Binding Dispute Resolution
For any Claim subject to, but not resolved by, mediation pursuant to Article 15 of AIA Document A201–2017, the method of binding dispute resolution shall be as follows:
(Check the appropriate box.)

[« »] Arbitration pursuant to Section 15.4 of AIA Document A201–2017

[« »] Litigation in a court of competent jurisdiction

[« »] Other *(Specify)*

« »

If the Owner and Contractor do not select a method of binding dispute resolution, or do not subsequently agree in writing to a binding dispute resolution method other than litigation, Claims will be resolved by litigation in a court of competent jurisdiction.

ARTICLE 7 TERMINATION OR SUSPENSION
§ 7.1 The Contract may be terminated by the Owner or the Contractor as provided in Article 14 of AIA Document A201–2017.

§ 7.1.1 If the Contract is terminated for the Owner's convenience in accordance with Article 14 of AIA Document A201–2017, then the Owner shall pay the Contractor a termination fee as follows:
(Insert the amount of, or method for determining, the fee, if any, payable to the Contractor following a termination for the Owner's convenience.)

« »

§ 7.2 The Work may be suspended by the Owner as provided in Article 14 of AIA Document A201–2017.

ARTICLE 8 MISCELLANEOUS PROVISIONS
§ 8.1 Where reference is made in this Agreement to a provision of AIA Document A201–2017 or another Contract Document, the reference refers to that provision as amended or supplemented by other provisions of the Contract Documents.

§ 8.2 The Owner's representative:
(Name, address, email address, and other information)

« »
« »
« »
« »
« »
« »

§ 8.3 The Contractor's representative:
(Name, address, email address, and other information)

« »
« »
« »
« »
« »
« »

§ 8.4 Neither the Owner's nor the Contractor's representative shall be changed without ten days' prior notice to the other party.

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§ 8.5 Insurance and Bonds

§ 8.5.1 The Owner and the Contractor shall purchase and maintain insurance as set forth in AIA Document A101™–2017, Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum, Exhibit A, Insurance and Bonds, and elsewhere in the Contract Documents.

§ 8.5.2 The Contractor shall provide bonds as set forth in AIA Document A101™–2017 Exhibit A, and elsewhere in the Contract Documents.

§ 8.6 Notice in electronic format, pursuant to Article 1 of AIA Document A201–2017, may be given in accordance with AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, if completed, or as otherwise set forth below:
(If other than in accordance with AIA Document E203–2013, insert requirements for delivering notice in electronic format such as name, title, and email address of the recipient and whether and how the system will be required to generate a read receipt for the transmission.)

« »

§ 8.7 Other provisions:

« »

ARTICLE 9 ENUMERATION OF CONTRACT DOCUMENTS

§ 9.1 This Agreement is comprised of the following documents:

.1 AIA Document A101™–2017, Standard Form of Agreement Between Owner and Contractor

.2 AIA Document A101™–2017, Exhibit A, Insurance and Bonds

.3 AIA Document A201™–2017, General Conditions of the Contract for Construction

.4 AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, dated as indicated below:
(Insert the date of the E203-2013 incorporated into this Agreement.)

« »

.5 Drawings

Number	Title	Date

.6 Specifications

Section	Title	Date	Pages

.7 Addenda, if any:

Number	Date	Pages

Portions of Addenda relating to bidding or proposal requirements are not part of the Contract Documents unless the bidding or proposal requirements are also enumerated in this Article 9.

.8 Other Exhibits:
(Check all boxes that apply and include appropriate information identifying the exhibit where required.)

[« »] AIA Document E204™–2017, Sustainable Projects Exhibit, dated as indicated below:
(Insert the date of the E204-2017 incorporated into this Agreement.)

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« »

[« »] The Sustainability Plan:

Title	Date	Pages

[« »] Supplementary and other Conditions of the Contract:

Document	Title	Date	Pages

.9 Other documents, if any, listed below:
(List here any additional documents that are intended to form part of the Contract Documents. AIA Document A201™–2017 provides that the advertisement or invitation to bid, Instructions to Bidders, sample forms, the Contractor's bid or proposal, portions of Addenda relating to bidding or proposal requirements, and other information furnished by the Owner in anticipation of receiving bids or proposals, are not part of the Contract Documents unless enumerated in this Agreement. Any such documents should be listed here only if intended to be part of the Contract Documents.)

« »

This Agreement entered into as of the day and year first written above.

OWNER *(Signature)*	**CONTRACTOR** *(Signature)*
« »« »	« »« »
(Printed name and title)	*(Printed name and title)*

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DRAFT

AIA® Document A201® – 2017

General Conditions of the Contract for Construction

for the following PROJECT:
(Name and location or address)

« »
« »

THE OWNER:
(Name, legal status and address)

« »« »
« »

THE ARCHITECT:
(Name, legal status and address)

« »« »
« »

TABLE OF ARTICLES

1 GENERAL PROVISIONS

2 OWNER

3 CONTRACTOR

4 ARCHITECT

5 SUBCONTRACTORS

6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

7 CHANGES IN THE WORK

8 TIME

9 PAYMENTS AND COMPLETION

10 PROTECTION OF PERSONS AND PROPERTY

11 INSURANCE AND BONDS

12 UNCOVERING AND CORRECTION OF WORK

13 MISCELLANEOUS PROVISIONS

14 TERMINATION OR SUSPENSION OF THE CONTRACT

15 CLAIMS AND DISPUTES

ADDITIONS AND DELETIONS: The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

For guidance in modifying this document to include supplementary conditions, see AIA Document A503™, Guide for Supplementary Conditions.

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INDEX
(Topics and numbers in bold are Section headings.)

Acceptance of Nonconforming Work
9.6.6, 9.9.3, **12.3**
Acceptance of Work
9.6.6, 9.8.2, 9.9.3, 9.10.1, 9.10.3, 12.3
Access to Work
3.16, 6.2.1, 12.1
Accident Prevention
10
Acts and Omissions
3.2, 3.3.2, 3.12.8, 3.18, 4.2.3, 8.3.1, 9.5.1, 10.2.5, 10.2.8, 13.3.2, 14.1, 15.1.2, 15.2
Addenda
1.1.1
Additional Costs, Claims for
3.7.4, 3.7.5, 10.3.2, 15.1.5
Additional Inspections and Testing
9.4.2, 9.8.3, 12.2.1, **13.4**
Additional Time, Claims for
3.2.4, 3.7.4, 3.7.5, 3.10.2, 8.3.2, **15.1.6**
Administration of the Contract
3.1.3, **4.2**, 9.4, 9.5
Advertisement or Invitation to Bid
1.1.1
Aesthetic Effect
4.2.13
Allowances
3.8
Applications for Payment
4.2.5, 7.3.9, 9.2, **9.3**, 9.4, 9.5.1, 9.5.4, 9.6.3, 9.7, 9.10
Approvals
2.1.1, 2.3.1, 2.5, 3.1.3, 3.10.2, 3.12.8, 3.12.9, 3.12.10.1, 4.2.7, 9.3.2, 13.4.1
Arbitration
8.3.1, 15.3.2, **15.4**
ARCHITECT
4
Architect, Definition of
4.1.1
Architect, Extent of Authority
2.5, 3.12.7, 4.1.2, 4.2, 5.2, 6.3, 7.1.2, 7.3.4, 7.4, 9.2, 9.3.1, 9.4, 9.5, 9.6.3, 9.8, 9.10.1, 9.10.3, 12.1, 12.2.1, 13.4.1, 13.4.2, 14.2.2, 14.2.4, 15.1.4, 15.2.1
Architect, Limitations of Authority and Responsibility
2.1.1, 3.12.4, 3.12.8, 3.12.10, 4.1.2, 4.2.1, 4.2.2, 4.2.3, 4.2.6, 4.2.7, 4.2.10, 4.2.12, 4.2.13, 5.2.1, 7.4, 9.4.2, 9.5.4, 9.6.4, 15.1.4, 15.2
Architect's Additional Services and Expenses
2.5, 12.2.1, 13.4.2, 13.4.3, 14.2.4
Architect's Administration of the Contract
3.1.3, 3.7.4, 15.2, 9.4.1, 9.5
Architect's Approvals
2.5, 3.1.3, 3.5, 3.10.2, 4.2.7
Architect's Authority to Reject Work
3.5, 4.2.6, 12.1.2, 12.2.1
Architect's Copyright
1.1.7, 1.5
Architect's Decisions
3.7.4, 4.2.6, 4.2.7, 4.2.11, 4.2.12, 4.2.13, 4.2.14, 6.3, 7.3.4, 7.3.9, 8.1.3, 8.3.1, 9.2, 9.4.1, 9.5, 9.8.4, 9.9.1, 13.4.2, 15.2
Architect's Inspections
3.7.4, 4.2.2, 4.2.9, 9.4.2, 9.8.3, 9.9.2, 9.10.1, 13.4
Architect's Instructions
3.2.4, 3.3.1, 4.2.6, 4.2.7, 13.4.2
Architect's Interpretations
4.2.11, 4.2.12
Architect's Project Representative
4.2.10
Architect's Relationship with Contractor
1.1.2, 1.5, 2.3.3, 3.1.3, 3.2.2, 3.2.3, 3.2.4, 3.3.1, 3.4.2, 3.5, 3.7.4, 3.7.5, 3.9.2, 3.9.3, 3.10, 3.11, 3.12, 3.16, 3.18, 4.1.2, 4.2, 5.2, 6.2.2, 7, 8.3.1, 9.2, 9.3, 9.4, 9.5, 9.7, 9.8, 9.9, 10.2.6, 10.3, 11.3, 12, 13.3.2, 13.4, 15.2
Architect's Relationship with Subcontractors
1.1.2, 4.2.3, 4.2.4, 4.2.6, 9.6.3, 9.6.4, 11.3
Architect's Representations
9.4.2, 9.5.1, 9.10.1
Architect's Site Visits
3.7.4, 4.2.2, 4.2.9, 9.4.2, 9.5.1, 9.9.2, 9.10.1, 13.4
Asbestos
10.3.1
Attorneys' Fees
3.18.1, 9.6.8, 9.10.2, 10.3.3
Award of Separate Contracts
6.1.1, 6.1.2
Award of Subcontracts and Other Contracts for Portions of the Work
5.2
Basic Definitions
1.1
Bidding Requirements
1.1.1
Binding Dispute Resolution
8.3.1, 9.7, 11.5, 13.1, 15.1.2, 15.1.3, 15.2.1, 15.2.5, 15.2.6.1, 15.3.1, 15.3.2, 15.3.3, 15.4.1
Bonds, Lien
7.3.4.4, 9.6.8, 9.10.2, 9.10.3
Bonds, Performance, and Payment
7.3.4.4, 9.6.7, 9.10.3, **11.1.2**, 11.1.3, **11.5**
Building Information Models Use and Reliance
1.8
Building Permit
3.7.1
Capitalization
1.3
Certificate of Substantial Completion
9.8.3, 9.8.4, 9.8.5
Certificates for Payment
4.2.1, 4.2.5, 4.2.9, 9.3.3, **9.4**, 9.5, 9.6.1, 9.6.6, 9.7, 9.10.1, 9.10.3, 14.1.1.3, 14.2.4, 15.1.4

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Certificates of Inspection, Testing or Approval
13.4.4
Certificates of Insurance
9.10.2
Change Orders
1.1.1, 3.4.2, 3.7.4, 3.8.2.3, 3.11, 3.12.8, 4.2.8, 5.2.3, 7.1.2, 7.1.3, **7.2**, 7.3.2, 7.3.7, 7.3.9, 7.3.10, 8.3.1, 9.3.1.1, 9.10.3, 10.3.2, 11.2, 11.5, 12.1.2
Change Orders, Definition of
7.2.1
CHANGES IN THE WORK
2.2.2, 3.11, 4.2.8, **7**, 7.2.1, 7.3.1, 7.4, 8.3.1, 9.3.1.1, 11.5
Claims, Definition of
15.1.1
Claims, Notice of
1.6.2, 15.1.3
CLAIMS AND DISPUTES
3.2.4, 6.1.1, 6.3, 7.3.9, 9.3.3, 9.10.4, 10.3.3, **15**, 15.4
Claims and Timely Assertion of Claims
15.4.1
Claims for Additional Cost
3.2.4, 3.3.1, 3.7.4, 7.3.9, 9.5.2, 10.2.5, 10.3.2, **15.1.5**
Claims for Additional Time
3.2.4, 3.3.1, 3.7.4, 6.1.1, 8.3.2, 9.5.2, 10.3.2, **15.1.6**
Concealed or Unknown Conditions, Claims for
3.7.4
Claims for Damages
3.2.4, 3.18, 8.3.3, 9.5.1, 9.6.7, 10.2.5, 10.3.3, 11.3, 11.3.2, 14.2.4, 15.1.7
Claims Subject to Arbitration
15.4.1
Cleaning Up
3.15, 6.3
Commencement of the Work, Conditions Relating to
2.2.1, 3.2.2, 3.4.1, 3.7.1, 3.10.1, 3.12.6, 5.2.1, 5.2.3, 6.2.2, 8.1.2, 8.2.2, 8.3.1, 11.1, 11.2, **15.1.5**
Commencement of the Work, Definition of
8.1.2
Communications
3.9.1, **4.2.4**
Completion, Conditions Relating to
3.4.1, 3.11, 3.15, 4.2.2, 4.2.9, 8.2, 9.4.2, 9.8, 9.9.1, 9.10, 12.2, 14.1.2, 15.1.2
COMPLETION, PAYMENTS AND
9
Completion, Substantial
3.10.1, 4.2.9, 8.1.1, 8.1.3, 8.2.3, 9.4.2, 9.8, 9.9.1, 9.10.3, 12.2, 15.1.2
Compliance with Laws
2.3.2, 3.2.3, 3.6, 3.7, 3.12.10, 3.13, 9.6.4, 10.2.2, 13.1, 13.3, 13.4.1, 13.4.2, 13.5, 14.1.1, 14.2.1.3, 15.2.8, 15.4.2, 15.4.3
Concealed or Unknown Conditions
3.7.4, 4.2.8, 8.3.1, 10.3
Conditions of the Contract
1.1.1, 6.1.1, 6.1.4
Consent, Written
3.4.2, 3.14.2, 4.1.2, 9.8.5, 9.9.1, 9.10.2, 9.10.3, 13.2, 15.4.4.2
Consolidation or Joinder
15.4.4
CONSTRUCTION BY OWNER OR BY
SEPARATE CONTRACTORS
1.1.4, **6**
Construction Change Directive, Definition of
7.3.1
Construction Change Directives
1.1.1, 3.4.2, 3.11, 3.12.8, 4.2.8, 7.1.1, 7.1.2, 7.1.3, **7.3**, 9.3.1.1
Construction Schedules, Contractor's
3.10, 3.11, 3.12.1, 3.12.2, 6.1.3, 15.1.6.2
Contingent Assignment of Subcontracts
5.4, 14.2.2.2
Continuing Contract Performance
15.1.4
Contract, Definition of
1.1.2
CONTRACT, TERMINATION OR
SUSPENSION OF THE
5.4.1.1, 5.4.2, 11.5, **14**
Contract Administration
3.1.3, 4, 9.4, 9.5
Contract Award and Execution, Conditions Relating to
3.7.1, 3.10, 5.2, 6.1
Contract Documents, Copies Furnished and Use of
1.5.2, 2.3.6, 5.3
Contract Documents, Definition of
1.1.1
Contract Sum
2.2.2, 2.2.4, 3.7.4, 3.7.5, 3.8, 3.10.2, 5.2.3, 7.3, 7.4, **9.1**, 9.2, 9.4.2, 9.5.1.4, 9.6.7, 9.7, 10.3.2, 11.5, 12.1.2, 12.3, 14.2.4, 14.3.2, 15.1.4.2, **15.1.5, 15.2.5**
Contract Sum, Definition of
9.1
Contract Time
1.1.4, 2.2.1, 2.2.2, 3.7.4, 3.7.5, 3.10.2, 5.2.3, 6.1.5, 7.2.1.3, 7.3.1, 7.3.5, 7.3.6, 7, 7, 7.3.10, 7.4, 8.1.1, 8.2.1, 8.2.3, 8.3.1, 9.5.1, 9.7, 10.3.2, 12.1.1, 12.1.2, 14.3.2, 15.1.4.2, 15.1.6.1, 15.2.5
Contract Time, Definition of
8.1.1
CONTRACTOR
3
Contractor, Definition of
3.1, 6.1.2
Contractor's Construction and Submittal
Schedules
3.10, 3.12.1, 3.12.2, 4.2.3, 6.1.3, 15.1.6.2
Contractor's Employees
2.2.4, 3.3.2, 3.4.3, 3.8.1, 3.9, 3.18.2, 4.2.3, 4.2.6, 10.2, 10.3, 11.3, 14.1, 14.2.1.1
Contractor's Liability Insurance
11.1

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Contractor's Relationship with Separate Contractors and Owner's Forces
3.12.5, 3.14.2, 4.2.4, 6, 11.3, 12.2.4
Contractor's Relationship with Subcontractors
1.2.2, 2.2.4, 3.3.2, 3.18.1, 3.18.2, 4.2.4, 5, 9.6.2, 9.6.7, 9.10.2, 11.2, 11.3, 11.4
Contractor's Relationship with the Architect
1.1.2, 1.5, 2.3.3, 3.1.3, 3.2.2, 3.2.3, 3.2.4, 3.3.1, 3.4.2, 3.5.1, 3.7.4, 3.10, 3.11, 3.12, 3.16, 3.18, 4.2, 5.2, 6.2.2, 7, 8.3.1, 9.2, 9.3, 9.4, 9.5, 9.7, 9.8, 9.9, 10.2.6, 10.3, 11.3, 12, 13.4, 15.1.3, 15.2.1
Contractor's Representations
3.2.1, 3.2.2, 3.5, 3.12.6, 6.2.2, 8.2.1, 9.3.3, 9.8.2
Contractor's Responsibility for Those Performing the Work
3.3.2, 3.18, 5.3, 6.1.3, 6.2, 9.5.1, 10.2.8
Contractor's Review of Contract Documents
3.2
Contractor's Right to Stop the Work
2.2.2, 9.7
Contractor's Right to Terminate the Contract
14.1
Contractor's Submittals
3.10, 3.11, 3.12, 4.2.7, 5.2.1, 5.2.3, 9.2, 9.3, 9.8.2, 9.8.3, 9.9.1, 9.10.2, 9.10.3
Contractor's Superintendent
3.9, 10.2.6
Contractor's Supervision and Construction Procedures
1.2.2, 3.3, 3.4, 3.12.10, 4.2.2, 4.2.7, 6.1.3, 6.2.4, 7.1.3, 7.3.4, 7.3.6, 8.2, 10, 12, 14, 15.1.4
Coordination and Correlation
1.2, 3.2.1, 3.3.1, 3.10, 3.12.6, 6.1.3, 6.2.1
Copies Furnished of Drawings and Specifications
1.5, 2.3.6, 3.11
Copyrights
1.5, **3.17**
Correction of Work
2.5, 3.7.3, 9.4.2, 9.8.2, 9.8.3, 9.9.1, 12.1.2, **12.2**, 12.3, 15.1.3.1, 15.1.3.2, 15.2.1
Correlation and Intent of the Contract Documents
1.2
Cost, Definition of
7.3.4
Costs
2.5, 3.2.4, 3.7.3, 3.8.2, 3.15.2, 5.4.2, 6.1.1, 6.2.3, 7.3.3.3, 7.3.4, 7.3.8, 7.3.9, 9.10.2, 10.3.2, 10.3.6, 11.2, 12.1.2, 12.2.1, 12.2.4, 13.4, 14
Cutting and Patching
3.14, 6.2.5
Damage to Construction of Owner or Separate Contractors
3.14.2, 6.2.4, 10.2.1.2, 10.2.5, 10.4, 12.2.4
Damage to the Work
3.14.2, 9.9.1, 10.2.1.2, 10.2.5, 10.4, 12.2.4
Damages, Claims for
3.2.4, 3.18, 6.1.1, 8.3.3, 9.5.1, 9.6.7, 10.3.3, 11.3.2, 11.3, 14.2.4, 15.1.7
Damages for Delay
6.2.3, 8.3.3, 9.5.1.6, 9.7, 10.3.2, 14.3.2
Date of Commencement of the Work, Definition of
8.1.2
Date of Substantial Completion, Definition of
8.1.3
Day, Definition of
8.1.4
Decisions of the Architect
3.7.4, 4.2.6, 4.2.7, 4.2.11, 4.2.12, 4.2.13, 6.3, 7.3.4, 7.3.9, 8.1.3, 8.3.1, 9.2, 9.4, 9.5.1, 9.8.4, 9.9.1, 13.4.2, 14.2.2, 14.2.4, 15.1, 15.2
Decisions to Withhold Certification
9.4.1, **9.5**, 9.7, 14.1.1.3
Defective or Nonconforming Work, Acceptance, Rejection and Correction of
2.5, 3.5, 4.2.6, 6.2.3, 9.5.1, 9.5.3, 9.6.6, 9.8.2, 9.9.3, 9.10.4, 12.2.1
Definitions
1.1, 2.1.1, 3.1.1, 3.5, 3.12.1, 3.12.2, 3.12.3, 4.1.1, 5.1, 6.1.2, 7.2.1, 7.3.1, 8.1, 9.1, 9.8.1, 15.1.1
Delays and Extensions of Time
3.2, **3.7.4**, 5.2.3, 7.2.1, 7.3.1, **7.4**, **8.3**, 9.5.1, **9.7**, 10.3.2, **10.4**, 14.3.2, **15.1.6**, 15.2.5
Digital Data Use and Transmission
1.7
Disputes
6.3, 7.3.9, 15.1, 15.2
Documents and Samples at the Site
3.11
Drawings, Definition of
1.1.5
Drawings and Specifications, Use and Ownership of
3.11
Effective Date of Insurance
8.2.2
Emergencies
10.4, 14.1.1.2, **15.1.5**
Employees, Contractor's
3.3.2, 3.4.3, 3.8.1, 3.9, 3.18.2, 4.2.3, 4.2.6, 10.2, 10.3.3, 11.3, 14.1, 14.2.1.1
Equipment, Labor, or Materials
1.1.3, 1.1.6, 3.4, 3.5, 3.8.2, 3.8.3, 3.12, 3.13, 3.15.1, 4.2.6, 4.2.7, 5.2.1, 6.2.1, 7.3.4, 9.3.2, 9.3.3, 9.5.1.3, 9.10.2, 10.2.1, 10.2.4, 14.2.1.1, 14.2.1.2
Execution and Progress of the Work
1.1.3, 1.2.1, 1.2.2, 2.3.4, 2.3.6, 3.1, 3.3.1, 3.4.1, 3.7.1, 3.10.1, 3.12, 3.14, 4.2, 6.2.2, 7.1.3, 7.3.6, 8.2, 9.5.1, 9.9.1, 10.2, 10.3, 12.1, 12.2, 14.2, 14.3.1, 15.1.4
Extensions of Time
3.2.4, 3.7.4, 5.2.3, 7.2.1, 7.3, 7.4, 9.5.1, 9.7, 10.3.2, 10.4, 14.3, 15.1.6, **15.2.5**
Failure of Payment
9.5.1.3, **9.7**, 9.10.2, 13.5, 14.1.1.3, 14.2.1.2
Faulty Work
(See Defective or Nonconforming Work)
Final Completion and Final Payment
4.2.1, 4.2.9, 9.8.2, **9.10**, 12.3, 14.2.4, 14.4.3

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Financial Arrangements, Owner's
2.2.1, 13.2.2, 14.1.1.4
GENERAL PROVISIONS
1
Governing Law
13.1
Guarantees (See Warranty)
Hazardous Materials and Substances
10.2.4, **10.3**
Identification of Subcontractors and Suppliers
5.2.1
Indemnification
3.17, **3.18**, 9.6.8, 9.10.2, 10.3.3, 11.3
Information and Services Required of the Owner
2.1.2, **2.2**, 2.3, 3.2.2, 3.12.10.1, 6.1.3, 6.1.4, 6.2.5, 9.6.1, 9.9.2, 9.10.3, 10.3.3, 11.2, 13.4.1, 13.4.2, 14.1.1.4, 14.1.4, 15.1.4
Initial Decision
15.2
Initial Decision Maker, Definition of
1.1.8
Initial Decision Maker, Decisions
14.2.4, 15.1.4.2, 15.2.1, 15.2.2, 15.2.3, 15.2.4, 15.2.5
Initial Decision Maker, Extent of Authority
14.2.4, 15.1.4.2, 15.2.1, 15.2.2, 15.2.3, 15.2.4, 15.2.5
Injury or Damage to Person or Property
10.2.8, 10.4
Inspections
3.1.3, 3.3.3, 3.7.1, 4.2.2, 4.2.6, 4.2.9, 9.4.2, 9.8.3, 9.9.2, 9.10.1, 12.2.1, 13.4
Instructions to Bidders
1.1.1
Instructions to the Contractor
3.2.4, 3.3.1, 3.8.1, 5.2.1, 7, 8.2.2, 12, 13.4.2
Instruments of Service, Definition of
1.1.7
Insurance
6.1.1, 7.3.4, 8.2.2, 9.3.2, 9.8.4, 9.9.1, 9.10.2, 10.2.5, **11**
Insurance, Notice of Cancellation or Expiration
11.1.4, 11.2.3
Insurance, Contractor's Liability
11.1
Insurance, Effective Date of
8.2.2, 14.4.2
Insurance, Owner's Liability
11.2
Insurance, Property
10.2.5, 11.2, 11.4, 11.5
Insurance, Stored Materials
9.3.2
INSURANCE AND BONDS
11
Insurance Companies, Consent to Partial Occupancy
9.9.1
Insured loss, Adjustment and Settlement of
11.5
Intent of the Contract Documents
1.2.1, 4.2.7, 4.2.12, 4.2.13
Interest
13.5
Interpretation
1.1.8, 1.2.3, **1.4**, 4.1.1, 5.1, 6.1.2, 15.1.1
Interpretations, Written
4.2.11, 4.2.12
Judgment on Final Award
15.4.2
Labor and Materials, Equipment
1.1.3, 1.1.6, **3.4**, 3.5, 3.8.2, 3.8.3, 3.12, 3.13, 3.15.1, 5.2.1, 6.2.1, 7.3.4, 9.3.2, 9.3.3, 9.5.1.3, 9.10.2, 10.2.1, 10.2.4, 14.2.1.1, 14.2.1.2
Labor Disputes
8.3.1
Laws and Regulations
1.5, 2.3.2, 3.2.3, 3.2.4, 3.6, 3.7, 3.12.10, 3.13, 9.6.4, 9.9.1, 10.2.2, 13.1, 13.3.1, 13.4.2, 13.5, 14, 15.2.8, 15.4
Liens
2.1.2, 9.3.1, 9.3.3, 9.6.8, 9.10.2, 9.10.4, 15.2.8
Limitations, Statutes of
12.2.5, 15.1.2, 15.4.1.1
Limitations of Liability
3.2.2, 3.5, 3.12.10, 3.12.10.1, 3.17, 3.18.1, 4.2.6, 4.2.7, 6.2.2, 9.4.2, 9.6.4, 9.6.7, 9.6.8, 10.2.5, 10.3.3, 11.3, 12.2.5, 13.3.1
Limitations of Time
2.1.2, 2.2, 2.5, 3.2.2, 3.10, 3.11, 3.12.5, 3.15.1, 4.2.7, 5.2, 5.3, 5.4.1, 6.2.4, 7.3, 7.4, 8.2, 9.2, 9.3.1, 9.3.3, 9.4.1, 9.5, 9.6, 9.7, 9.8, 9.9, 9.10, 12.2, 13.4, 14, 15, 15.1.2, 15.1.3, 15.1.5
Materials, Hazardous
10.2.4, **10.3**
Materials, Labor, Equipment and
1.1.3, 1.1.6, 3.4.1, 3.5, 3.8.2, 3.8.3, 3.12, 3.13, 3.15.1, 5.2.1, 6.2.1, 7.3.4, 9.3.2, 9.3.3, 9.5.1.3, 9.10.2, 10.2.1.2, 10.2.4, 14.2.1.1, 14.2.1.2
Means, Methods, Techniques, Sequences and Procedures of Construction
3.3.1, 3.12.10, 4.2.2, 4.2.7, 9.4.2
Mechanic's Lien
2.1.2, 9.3.1, 9.3.3, 9.6.8, 9.10.2, 9.10.4, 15.2.8
Mediation
8.3.1, 15.1.3.2, 15.2.1, 15.2.5, 15.2.6, **15.3**, 15.4.1, 15.4.1.1
Minor Changes in the Work
1.1.1, 3.4.2, 3.12.8, 4.2.8, 7.1, **7.4**
MISCELLANEOUS PROVISIONS
13
Modifications, Definition of
1.1.1
Modifications to the Contract
1.1.1, 1.1.2, 2.5, 3.11, 4.1.2, 4.2.1, 5.2.3, 7, 8.3.1, 9.7, 10.3.2
Mutual Responsibility
6.2

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Nonconforming Work, Acceptance of
9.6.6, 9.9.3, **12.3**
Nonconforming Work, Rejection and Correction of
2.4, 2.5, 3.5, 4.2.6, 6.2.4, 9.5.1, 9.8.2, 9.9.3, 9.10.4, 12.2
Notice
1.6, 1.6.1, 1.6.2, 2.1.2, 2.2.2., 2.2.3, 2.2.4, 2.5, 3.2.4, 3.3.1, 3.7.4, 3.7.5, 3.9.2, 3.12.9, 3.12.10, 5.2.1, 7.4, 8.2.2 9.6.8, 9.7, 9.10.1, 10.2.8, 10.3.2, 11.5, 12.2.2.1, 13.4.1, 13.4.2, 14.1, 14.2.2, 14.4.2, 15.1.3, 15.1.5, 15.1.6, 15.4.1
Notice of Cancellation or Expiration of Insurance
11.1.4, 11.2.3
Notice of Claims
1.6.2, 2.1.2, 3.7.4, 9.6.8, 10.2.8, **15.1.3**, 15.1.5, 15.1.6, 15.2.8, 15.3.2, 15.4.1
Notice of Testing and Inspections
13.4.1, 13.4.2
Observations, Contractor's
3.2, 3.7.4
Occupancy
2.3.1, 9.6.6, 9.8
Orders, Written
1.1.1, 2.4, 3.9.2, 7, 8.2.2, 11.5, 12.1, 12.2.2.1, 13.4.2, 14.3.1
OWNER
2
Owner, Definition of
2.1.1
Owner, Evidence of Financial Arrangements
2.2, 13.2.2, 14.1.1.4
Owner, Information and Services Required of the
2.1.2, **2.2**, 2.3, 3.2.2, 3.12.10, 6.1.3, 6.1.4, 6.2.5, 9.3.2, 9.6.1, 9.6.4, 9.9.2, 9.10.3, 10.3.3, 11.2, 13.4.1, 13.4.2, 14.1.1.4, 14.1.4, 15.1.4
Owner's Authority
1.5, 2.1.1, 2.3.32.4, 2.5, 3.4.2, 3.8.1, 3.12.10, 3.14.2, 4.1.2, 4.2.4, 4.2.9, 5.2.1, 5.2.4, 5.4.1, 6.1, 6.3, 7.2.1, 7.3.1, 8.2.2, 8.3.1, 9.3.2, 9.5.1, 9.6.4, 9.9.1, 9.10.2, 10.3.2, 11.4, 11.5, 12.2.2, 12.3, 13.2.2, 14.3, 14.4, 15.2.7
Owner's Insurance
11.2
Owner's Relationship with Subcontractors
1.1.2, 5.2, 5.3, 5.4, 9.6.4, 9.10.2, 14.2.2
Owner's Right to Carry Out the Work
2.5, 14.2.2
Owner's Right to Clean Up
6.3
Owner's Right to Perform Construction and to Award Separate Contracts
6.1
Owner's Right to Stop the Work
2.4
Owner's Right to Suspend the Work
14.3
Owner's Right to Terminate the Contract
14.2, 14.4
Ownership and Use of Drawings, Specifications and Other Instruments of Service
1.1.1, 1.1.6, 1.1.7, **1.5**, 2.3.6, 3.2.2, 3.11, 3.17, 4.2.12, 5.3
Partial Occupancy or Use
9.6.6, **9.9**
Patching, Cutting and
3.14, 6.2.5
Patents
3.17
Payment, Applications for
4.2.5, 7.3.9, 9.2, **9.3**, 9.4, 9.5, 9.6.3, 9.7, 9.8.5, 9.10.1, 14.2.3, 14.2.4, 14.4.3
Payment, Certificates for
4.2.5, 4.2.9, 9.3.3, **9.4**, 9.5, 9.6.1, 9.6.6, 9.7, 9.10.1, 9.10.3, 14.1.1.3, 14.2.4
Payment, Failure of
9.5.1.3, **9.7**, 9.10.2, 13.5, 14.1.1.3, 14.2.1.2
Payment, Final
4.2.1, 4.2.9, **9.10**, 12.3, 14.2.4, 14.4.3
Payment Bond, Performance Bond and
7.3.4.4, 9.6.7, 9.10.3, **11.1.2**
Payments, Progress
9.3, **9.6**, 9.8.5, 9.10.3, 14.2.3, 15.1.4
PAYMENTS AND COMPLETION
9
Payments to Subcontractors
5.4.2, 9.5.1.3, 9.6.2, 9.6.3, 9.6.4, 9.6.7, 14.2.1.2
PCB
10.3.1
Performance Bond and Payment Bond
7.3.4.4, 9.6.7, 9.10.3, **11.1.2**
Permits, Fees, Notices and Compliance with Laws
2.3.1, **3.7**, 3.13, 7.3.4.4, 10.2.2
PERSONS AND PROPERTY, PROTECTION OF
10
Polychlorinated Biphenyl
10.3.1
Product Data, Definition of
3.12.2
Product Data and Samples, Shop Drawings
3.11, **3.12**, 4.2.7
Progress and Completion
4.2.2, **8.2**, 9.8, 9.9.1, 14.1.4, 15.1.4
Progress Payments
9.3, **9.6**, 9.8.5, 9.10.3, 14.2.3, 15.1.4
Project, Definition of
1.1.4
Project Representatives
4.2.10
Property Insurance
10.2.5, **11.2**
Proposal Requirements
1.1.1
PROTECTION OF PERSONS AND PROPERTY
10

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Regulations and Laws
1.5, 2.3.2, 3.2.3, 3.6, 3.7, 3.12.10, 3.13, 9.6.4, 9.9.1, 10.2.2, 13.1, 13.3, 13.4.1, 13.4.2, 13.5, 14, 15.2.8, 15.4
Rejection of Work
4.2.6, 12.2.1
Releases and Waivers of Liens
9.3.1, 9.10.2
Representations
3.2.1, 3.5, 3.12.6, 8.2.1, 9.3.3, 9.4.2, 9.5.1, 9.10.1
Representatives
2.1.1, 3.1.1, 3.9, 4.1.1, 4.2.10, 13.2.1
Responsibility for Those Performing the Work
3.3.2, 3.18, 4.2.2, 4.2.3, 5.3, 6.1.3, 6.2, 6.3, 9.5.1, 10
Retainage
9.3.1, 9.6.2, 9.8.5, 9.9.1, 9.10.2, 9.10.3
Review of Contract Documents and Field Conditions by Contractor
3.2, 3.12.7, 6.1.3
Review of Contractor's Submittals by Owner and Architect
3.10.1, 3.10.2, 3.11, 3.12, 4.2, 5.2, 6.1.3, 9.2, 9.8.2
Review of Shop Drawings, Product Data and Samples by Contractor
3.12
Rights and Remedies
1.1.2, 2.4, 2.5, 3.5, 3.7.4, 3.15.2, 4.2.6, 5.3, 5.4, 6.1, 6.3, 7.3.1, 8.3, 9.5.1, 9.7, 10.2.5, 10.3, 12.2.1, 12.2.2, 12.2.4, **13.3**, 14, 15.4
Royalties, Patents and Copyrights
3.17
Rules and Notices for Arbitration
15.4.1
Safety of Persons and Property
10.2, 10.4
Safety Precautions and Programs
3.3.1, 4.2.2, 4.2.7, 5.3, **10.1**, 10.2, 10.4
Samples, Definition of
3.12.3
Samples, Shop Drawings, Product Data and
3.11, **3.12**, 4.2.7
Samples at the Site, Documents and
3.11
Schedule of Values
9.2, 9.3.1
Schedules, Construction
3.10, 3.12.1, 3.12.2, 6.1.3, 15.1.6.2
Separate Contracts and Contractors
1.1.4, 3.12.5, 3.14.2, 4.2.4, 4.2.7, 6, 8.3.1, 12.1.2
Separate Contractors, Definition of
6.1.1
Shop Drawings, Definition of
3.12.1
Shop Drawings, Product Data and Samples
3.11, **3.12**, 4.2.7
Site, Use of
3.13, 6.1.1, 6.2.1
Site Inspections
3.2.2, 3.3.3, 3.7.1, 3.7.4, 4.2, 9.9.2, 9.4.2, 9.10.1, 13.4
Site Visits, Architect's
3.7.4, 4.2.2, 4.2.9, 9.4.2, 9.5.1, 9.9.2, 9.10.1, 13.4
Special Inspections and Testing
4.2.6, 12.2.1, 13.4
Specifications, Definition of
1.1.6
Specifications
1.1.1, **1.1.6**, 1.2.2, 1.5, 3.12.10, 3.17, 4.2.14
Statute of Limitations
15.1.2, 15.4.1.1
Stopping the Work
2.2.2, 2.4, 9.7, 10.3, 14.1
Stored Materials
6.2.1, 9.3.2, 10.2.1.2, 10.2.4
Subcontractor, Definition of
5.1.1
SUBCONTRACTORS
5
Subcontractors, Work by
1.2.2, 3.3.2, 3.12.1, 3.18, 4.2.3, 5.2.3, 5.3, 5.4, 9.3.1.2, 9.6.7
Subcontractual Relations
5.3, 5.4, 9.3.1.2, 9.6, 9.10, 10.2.1, 14.1, 14.2.1
Submittals
3.10, 3.11, 3.12, 4.2.7, 5.2.1, 5.2.3, 7.3.4, 9.2, 9.3, 9.8, 9.9.1, 9.10.2, 9.10.3
Submittal Schedule
3.10.2, 3.12.5, 4.2.7
Subrogation, Waivers of
6.1.1, **11.3**
Substances, Hazardous
10.3
Substantial Completion
4.2.9, 8.1.1, 8.1.3, 8.2.3, 9.4.2, **9.8**, 9.9.1, 9.10.3, 12.2, 15.1.2
Substantial Completion, Definition of
9.8.1
Substitution of Subcontractors
5.2.3, 5.2.4
Substitution of Architect
2.3.3
Substitutions of Materials
3.4.2, 3.5, 7.3.8
Sub-subcontractor, Definition of
5.1.2
Subsurface Conditions
3.7.4
Successors and Assigns
13.2
Superintendent
3.9, 10.2.6
Supervision and Construction Procedures
1.2.2, **3.3**, 3.4, 3.12.10, 4.2.2, 4.2.7, 6.1.3, 6.2.4, 7.1.3, 7.3.4, 8.2, 8.3.1, 9.4.2, 10, 12, 14, 15.1.4

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Suppliers
1.5, 3.12.1, 4.2.4, 4.2.6, 5.2.1, 9.3, 9.4.2, 9.5.4, 9.6, 9.10.5, 14.2.1
Surety
5.4.1.2, 9.6.8, 9.8.5, 9.10.2, 9.10.3, 11.1.2, 14.2.2, 15.2.7
Surety, Consent of
9.8.5, 9.10.2, 9.10.3
Surveys
1.1.7, 2.3.4
Suspension by the Owner for Convenience
14.3
Suspension of the Work
3.7.5, 5.4.2, 14.3
Suspension or Termination of the Contract
5.4.1.1, 14
Taxes
3.6, 3.8.2.1, 7.3.4.4
Termination by the Contractor
14.1, 15.1.7
Termination by the Owner for Cause
5.4.1.1, **14.2,** 15.1.7
Termination by the Owner for Convenience
14.4
Termination of the Architect
2.3.3
Termination of the Contractor Employment
14.2.2

TERMINATION OR SUSPENSION OF THE CONTRACT
14
Tests and Inspections
3.1.3, 3.3.3, 3.7.1, 4.2.2, 4.2.6, 4.2.9, 9.4.2, 9.8.3, 9.9.2, 9.10.1, 10.3.2, 12.2.1, **13.4**
TIME
8
Time, Delays and Extensions of
3.2.4, 3.7.4, 5.2.3, 7.2.1, 7.3.1, 7.4, **8.3**, 9.5.1, 9.7, 10.3.2, 10.4, 14.3.2, 15.1.6, 15.2.5
Time Limits
2.1.2, 2.2, 2.5, 3.2.2, 3.10, 3.11, 3.12.5, 3.15.1, 4.2, 5.2, 5.3, 5.4, 6.2.4, 7.3, 7.4, 8.2, 9.2, 9.3.1, 9.3.3, 9.4.1, 9.5, 9.6, 9.7, 9.8, 9.9, 9.10, 12.2, 13.4, 14, 15.1.2, 15.1.3, 15.4
Time Limits on Claims
3.7.4, 10.2.8, 15.1.2, 15.1.3
Title to Work
9.3.2, 9.3.3
UNCOVERING AND CORRECTION OF WORK
12
Uncovering of Work
12.1
Unforeseen Conditions, Concealed or Unknown
3.7.4, 8.3.1, 10.3
Unit Prices
7.3.3.2, 9.1.2
Use of Documents
1.1.1, 1.5, 2.3.6, 3.12.6, 5.3
Use of Site
3.13, 6.1.1, 6.2.1
Values, Schedule of
9.2, 9.3.1
Waiver of Claims by the Architect
13.3.2
Waiver of Claims by the Contractor
9.10.5, 13.3.2, **15.1.7**
Waiver of Claims by the Owner
9.9.3, 9.10.3, 9.10.4, 12.2.2.1, 13.3.2, 14.2.4, **15.1.7**
Waiver of Consequential Damages
14.2.4, 15.1.7
Waiver of Liens
9.3, 9.10.2, 9.10.4
Waivers of Subrogation
6.1.1, **11.3**
Warranty
3.5, 4.2.9, 9.3.3, 9.8.4, 9.9.1, 9.10.2, 9.10.4, 12.2.2, 15.1.2
Weather Delays
8.3, 15.1.6.2
Work, Definition of
1.1.3
Written Consent
1.5.2, 3.4.2, 3.7.4, 3.12.8, 3.14.2, 4.1.2, 9.3.2, 9.10.3, 13.2, 13.3.2, 15.4.4.2
Written Interpretations
4.2.11, 4.2.12
Written Orders
1.1.1, 2.4, 3.9, 7, 8.2.2, 12.1, 12.2, 13.4.2, 14.3.1

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ARTICLE 1 GENERAL PROVISIONS

§ 1.1 Basic Definitions

§ 1.1.1 The Contract Documents

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement, and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive, or (4) a written order for a minor change in the Work issued by the Architect. Unless specifically enumerated in the Agreement, the Contract Documents do not include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, the Contractor's bid or proposal, or portions of Addenda relating to bidding or proposal requirements.

§ 1.1.2 The Contract

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Architect or the Architect's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Architect or the Architect's consultants, or (4) between any persons or entities other than the Owner and the Contractor. The Architect shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Architect's duties.

§ 1.1.3 The Work

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

§ 1.1.4 The Project

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by Separate Contractors.

§ 1.1.5 The Drawings

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 The Specifications

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

§ 1.1.7 Instruments of Service

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

§ 1.1.8 Initial Decision Maker

The Initial Decision Maker is the person identified in the Agreement to render initial decisions on Claims in accordance with Section 15.2. The Initial Decision Maker shall not show partiality to the Owner or Contractor and shall not be liable for results of interpretations or decisions rendered in good faith.

§ 1.2 Correlation and Intent of the Contract Documents

§ 1.2.1 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results.

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§ 1.2.1.1 The invalidity of any provision of the Contract Documents shall not invalidate the Contract or its remaining provisions. If it is determined that any provision of the Contract Documents violates any law, or is otherwise invalid or unenforceable, then that provision shall be revised to the extent necessary to make that provision legal and enforceable. In such case the Contract Documents shall be construed, to the fullest extent permitted by law, to give effect to the parties' intentions and purposes in executing the Contract.

§ 1.2.2 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

§ 1.2.3 Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

§ 1.3 Capitalization

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles, or (3) the titles of other documents published by the American Institute of Architects.

§ 1.4 Interpretation

In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

§ 1.5 Ownership and Use of Drawings, Specifications, and Other Instruments of Service

§ 1.5.1 The Architect and the Architect's consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and retain all common law, statutory, and other reserved rights in their Instruments of Service, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with the Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

§ 1.5.2 The Contractor, Subcontractors, Sub-subcontractors, and suppliers are authorized to use and reproduce the Instruments of Service provided to them, subject to any protocols established pursuant to Sections 1.7 and 1.8, solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and suppliers may not use the Instruments of Service on other projects or for additions to the Project outside the scope of the Work without the specific written consent of the Owner, Architect, and the Architect's consultants.

§ 1.6 Notice

§ 1.6.1 Except as otherwise provided in Section 1.6.2, where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by mail, by courier, or by electronic transmission if a method for electronic transmission is set forth in the Agreement.

§ 1.6.2 Notice of Claims as provided in Section 15.1.3 shall be provided in writing and shall be deemed to have been duly served only if delivered to the designated representative of the party to whom the notice is addressed by certified or registered mail, or by courier providing proof of delivery.

§ 1.7 Digital Data Use and Transmission

The parties shall agree upon protocols governing the transmission and use of Instruments of Service or any other information or documentation in digital form. The parties will use AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, to establish the protocols for the development, use, transmission, and exchange of digital data.

§ 1.8 Building Information Models Use and Reliance

Any use of, or reliance on, all or a portion of a building information model without agreement to protocols governing the use of, and reliance on, the information contained in the model and without having those protocols set forth in AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, and the requisite AIA Document G202™–2013, Project Building Information Modeling Protocol Form, shall be at the using or

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relying party's sole risk and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees.

ARTICLE 2 OWNER

§ 2.1 General

§ 2.1.1 The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative.

§ 2.1.2 The Owner shall furnish to the Contractor, within fifteen days after receipt of a written request, information necessary and relevant for the Contractor to evaluate, give notice of, or enforce mechanic's lien rights. Such information shall include a correct statement of the record legal title to the property on which the Project is located, usually referred to as the site, and the Owner's interest therein.

§ 2.2 Evidence of the Owner's Financial Arrangements

§ 2.2.1 Prior to commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. The Contractor shall have no obligation to commence the Work until the Owner provides such evidence. If commencement of the Work is delayed under this Section 2.2.1, the Contract Time shall be extended appropriately.

§ 2.2.2 Following commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract only if (1) the Owner fails to make payments to the Contractor as the Contract Documents require; (2) the Contractor identifies in writing a reasonable concern regarding the Owner's ability to make payment when due; or (3) a change in the Work materially changes the Contract Sum. If the Owner fails to provide such evidence, as required, within fourteen days of the Contractor's request, the Contractor may immediately stop the Work and, in that event, shall notify the Owner that the Work has stopped. However, if the request is made because a change in the Work materially changes the Contract Sum under (3) above, the Contractor may immediately stop only that portion of the Work affected by the change until reasonable evidence is provided. If the Work is stopped under this Section 2.2.2, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided in the Contract Documents.

§ 2.2.3 After the Owner furnishes evidence of financial arrangements under this Section 2.2, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

§ 2.2.4 Where the Owner has designated information furnished under this Section 2.2 as "confidential," the Contractor shall keep the information confidential and shall not disclose it to any other person. However, the Contractor may disclose "confidential" information, after seven (7) days' notice to the Owner, where disclosure is required by law, including a subpoena or other form of compulsory legal process issued by a court or governmental entity, or by court or arbitrator(s) order. The Contractor may also disclose "confidential" information to its employees, consultants, sureties, Subcontractors and their employees, Sub-subcontractors, and others who need to know the content of such information solely and exclusively for the Project and who agree to maintain the confidentiality of such information.

§ 2.3 Information and Services Required of the Owner

§ 2.3.1 Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

§ 2.3.2 The Owner shall retain an architect lawfully licensed to practice architecture, or an entity lawfully practicing architecture, in the jurisdiction where the Project is located. That person or entity is identified as the Architect in the Agreement and is referred to throughout the Contract Documents as if singular in number.

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§ 2.3.3 If the employment of the Architect terminates, the Owner shall employ a successor to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect.

§ 2.3.4 The Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. The Contractor shall be entitled to rely on the accuracy of information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Work.

§ 2.3.5 The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services.

§ 2.3.6 Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions pursuant to Section 1.5.2.

§ 2.4 Owner's Right to Stop the Work

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by Section 12.2 or repeatedly fails to carry out Work in accordance with the Contract Documents, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3.

§ 2.5 Owner's Right to Carry Out the Work

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a ten-day period after receipt of notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect and the Architect may, pursuant to Section 9.5.1, withhold or nullify a Certificate for Payment in whole or in part, to the extent reasonably necessary to reimburse the Owner for the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Architect's additional services made necessary by such default, neglect, or failure. If current and future payments are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. If the Contractor disagrees with the actions of the Owner or the Architect, or the amounts claimed as costs to the Owner, the Contractor may file a Claim pursuant to Article 15.

ARTICLE 3 CONTRACTOR

§ 3.1 General

§ 3.1.1 The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

§ 3.1.2 The Contractor shall perform the Work in accordance with the Contract Documents.

§ 3.1.3 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Architect in the Architect's administration of the Contract, or by tests, inspections or approvals required or performed by persons or entities other than the Contractor.

§ 3.2 Review of Contract Documents and Field Conditions by Contractor

§ 3.2.1 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed, and correlated personal observations with requirements of the Contract Documents.

§ 3.2.2 Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as

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the information furnished by the Owner pursuant to Section 2.3.4, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Architect any errors, inconsistencies or omissions discovered by or made known to the Contractor as a request for information in such form as the Architect may require. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

§ 3.2.3 The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Architect any nonconformity discovered by or made known to the Contractor as a request for information in such form as the Architect may require.

§ 3.2.4 If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to Sections 3.2.2 or 3.2.3, the Contractor shall submit Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2.2 or 3.2.3, the Contractor shall pay such costs and damages to the Owner, subject to Section 15.1.7, as would have been avoided if the Contractor had performed such obligations. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Architect for damages resulting from errors, inconsistencies or omissions in the Contract Documents, for differences between field measurements or conditions and the Contract Documents, or for nonconformities of the Contract Documents to applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities.

§ 3.3 Supervision and Construction Procedures

§ 3.3.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences, and procedures, and for coordinating all portions of the Work under the Contract. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences, or procedures, the Contractor shall evaluate the jobsite safety thereof and shall be solely responsible for the jobsite safety of such means, methods, techniques, sequences, or procedures. If the Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely notice to the Owner and Architect, and shall propose alternative means, methods, techniques, sequences, or procedures. The Architect shall evaluate the proposed alternative solely for conformance with the design intent for the completed construction. Unless the Architect objects to the Contractor's proposed alternative, the Contractor shall perform the Work using its alternative means, methods, techniques, sequences, or procedures.

§ 3.3.2 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of the Work for, or on behalf of, the Contractor or any of its Subcontractors.

§ 3.3.3 The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

§ 3.4 Labor and Materials

§ 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

§ 3.4.2 Except in the case of minor changes in the Work approved by the Architect in accordance with Section 3.12.8 or ordered by the Architect in accordance with Section 7.4, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with a Change Order or Construction Change Directive.

§ 3.4.3 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Work. The Contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned to them.

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§ 3.5 Warranty

§ 3.5.1 The Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

§ 3.5.2 All material, equipment, or other special warranties required by the Contract Documents shall be issued in the name of the Owner, or shall be transferable to the Owner, and shall commence in accordance with Section 9.8.4.

§ 3.6 Taxes

The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect.

§ 3.7 Permits, Fees, Notices and Compliance with Laws

§ 3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

§ 3.7.2 The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

§ 3.7.3 If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect before conditions are disturbed and in no event later than 14 days after first observance of the conditions. The Architect will promptly investigate such conditions and, if the Architect determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend that an equitable adjustment be made in the Contract Sum or Contract Time, or both. If the Architect determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect shall promptly notify the Owner and Contractor, stating the reasons. If either party disputes the Architect's determination or recommendation, that party may submit a Claim as provided in Article 15.

§ 3.7.5 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

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§ 3.8 Allowances

§ 3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

§ 3.8.2 Unless otherwise provided in the Contract Documents,

- **.1** allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- **.2** Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and
- **.3** whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

§ 3.8.3 Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

§ 3.9 Superintendent

§ 3.9.1 The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.

§ 3.9.2 The Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the name and qualifications of a proposed superintendent. Within 14 days of receipt of the information, the Architect may notify the Contractor, stating whether the Owner or the Architect (1) has reasonable objection to the proposed superintendent or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 3.9.3 The Contractor shall not employ a proposed superintendent to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not unreasonably be withheld or delayed.

§ 3.10 Contractor's Construction and Submittal Schedules

§ 3.10.1 The Contractor, promptly after being awarded the Contract, shall submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall contain detail appropriate for the Project, including (1) the date of commencement of the Work, interim schedule milestone dates, and the date of Substantial Completion; (2) an apportionment of the Work by construction activity; and (3) the time required for completion of each portion of the Work. The schedule shall provide for the orderly progression of the Work to completion and shall not exceed time limits current under the Contract Documents. The schedule shall be revised at appropriate intervals as required by the conditions of the Work and Project.

§ 3.10.2 The Contractor, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, shall submit a submittal schedule for the Architect's approval. The Architect's approval shall not be unreasonably delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Architect reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, or fails to provide submittals in accordance with the approved submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

§ 3.10.3 The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect.

§ 3.11 Documents and Samples at the Site

The Contractor shall make available, at the Project site, the Contract Documents, including Change Orders, Construction Change Directives, and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and the approved Shop Drawings, Product Data, Samples, and

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similar required submittals. These shall be in electronic form or paper copy, available to the Architect and Owner, and delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

§ 3.12 Shop Drawings, Product Data and Samples

§ 3.12.1 Shop Drawings are drawings, diagrams, schedules, and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

§ 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

§ 3.12.3 Samples are physical examples that illustrate materials, equipment, or workmanship, and establish standards by which the Work will be judged.

§ 3.12.4 Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents. Their purpose is to demonstrate how the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Architect is subject to the limitations of Section 4.2.7. Informational submittals upon which the Architect is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Architect without action.

§ 3.12.5 The Contractor shall review for compliance with the Contract Documents, approve, and submit to the Architect, Shop Drawings, Product Data, Samples, and similar submittals required by the Contract Documents, in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of Separate Contractors.

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

§ 3.12.7 The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals, until the respective submittal has been approved by the Architect.

§ 3.12.8 The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data, Samples, or similar submittals, unless the Contractor has specifically notified the Architect of such deviation at the time of submittal and (1) the Architect has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals, by the Architect's approval thereof.

§ 3.12.9 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples, or similar submittals, to revisions other than those requested by the Architect on previous submittals. In the absence of such notice, the Architect's approval of a resubmission shall not apply to such revisions.

§ 3.12.10 The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures. The Contractor shall not be required to provide professional services in violation of applicable law.

§ 3.12.10.1 If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will

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specify all performance and design criteria that such services must satisfy. The Contractor shall be entitled to rely upon the adequacy and accuracy of the performance and design criteria provided in the Contract Documents. The Contractor shall cause such services or certifications to be provided by an appropriately licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by such professional. Shop Drawings, and other submittals related to the Work, designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Architect. The Owner and the Architect shall be entitled to rely upon the adequacy and accuracy of the services, certifications, and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor the performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review and approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

§ 3.12.10.2 If the Contract Documents require the Contractor's design professional to certify that the Work has been performed in accordance with the design criteria, the Contractor shall furnish such certifications to the Architect at the time and in the form specified by the Architect.

§ 3.13 Use of Site

The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, lawful orders of public authorities, and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

§ 3.14 Cutting and Patching

§ 3.14.1 The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting, or patching shall be restored to the condition existing prior to the cutting, fitting, or patching, unless otherwise required by the Contract Documents.

§ 3.14.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or Separate Contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter construction by the Owner or a Separate Contractor except with written consent of the Owner and of the Separate Contractor. Consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold, from the Owner or a Separate Contractor, its consent to cutting or otherwise altering the Work.

§ 3.15 Cleaning Up

§ 3.15.1 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials and rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus materials from and about the Project.

§ 3.15.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the Owner shall be entitled to reimbursement from the Contractor.

§ 3.16 Access to Work

The Contractor shall provide the Owner and Architect with access to the Work in preparation and progress wherever located.

§ 3.17 Royalties, Patents and Copyrights

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Architect harmless from loss on account thereof, but shall not be responsible for defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications, or other documents prepared by the Owner or Architect. However, if an infringement of a copyright or patent is discovered by, or made known to, the Contractor, the Contractor shall be responsible for the loss unless the information is promptly furnished to the Architect.

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§ 3.18 Indemnification

§ 3.18.1 To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section 3.18.

§ 3.18.2 In claims against any person or entity indemnified under this Section 3.18 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, the indemnification obligation under Section 3.18.1 shall not be limited by a limitation on amount or type of damages, compensation, or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts, or other employee benefit acts.

ARTICLE 4 ARCHITECT

§ 4.1 General

§ 4.1.1 The Architect is the person or entity retained by the Owner pursuant to Section 2.3.2 and identified as such in the Agreement.

§ 4.1.2 Duties, responsibilities, and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified, or extended without written consent of the Owner, Contractor, and Architect. Consent shall not be unreasonably withheld.

§ 4.2 Administration of the Contract

§ 4.2.1 The Architect will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction until the date the Architect issues the final Certificate for Payment. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

§ 4.2.2 The Architect will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect will not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents.

§ 4.2.3 On the basis of the site visits, the Architect will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and promptly report to the Owner (1) known deviations from the Contract Documents, (2) known deviations from the most recent construction schedule submitted by the Contractor, and (3) defects and deficiencies observed in the Work. The Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of, and will not be responsible for acts or omissions of, the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

§ 4.2.4 Communications

The Owner and Contractor shall include the Architect in all communications that relate to or affect the Architect's services or professional responsibilities. The Owner shall promptly notify the Architect of the substance of any direct communications between the Owner and the Contractor otherwise relating to the Project. Communications by and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and suppliers shall be through the Contractor. Communications by and with Separate Contractors shall be through the Owner. The Contract Documents may specify other communication protocols.

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§ 4.2.5 Based on the Architect's evaluations of the Contractor's Applications for Payment, the Architect will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

§ 4.2.6 The Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will have authority to require inspection or testing of the Work in accordance with Sections 13.4.2 and 13.4.3, whether or not the Work is fabricated, installed or completed. However, neither this authority of the Architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, suppliers, their agents or employees, or other persons or entities performing portions of the Work.

§ 4.2.7 The Architect will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data, and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Architect's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5, and 3.12. The Architect's review shall not constitute approval of safety precautions or of any construction means, methods, techniques, sequences, or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

§ 4.2.8 The Architect will prepare Change Orders and Construction Change Directives, and may order minor changes in the Work as provided in Section 7.4. The Architect will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

§ 4.2.9 The Architect will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to Section 9.8; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to Section 9.10; and issue a final Certificate for Payment pursuant to Section 9.10.

§ 4.2.10 If the Owner and Architect agree, the Architect will provide one or more Project representatives to assist in carrying out the Architect's responsibilities at the site. The Owner shall notify the Contractor of any change in the duties, responsibilities and limitations of authority of the Project representatives.

§ 4.2.11 The Architect will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

§ 4.2.12 Interpretations and decisions of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings. When making such interpretations and decisions, the Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either, and will not be liable for results of interpretations or decisions rendered in good faith.

§ 4.2.13 The Architect's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

§ 4.2.14 The Architect will review and respond to requests for information about the Contract Documents. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

§ 5.1 Definitions

§ 5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in

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number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a Separate Contractor or the subcontractors of a Separate Contractor.

§ 5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

§ 5.2 Award of Subcontracts and Other Contracts for Portions of the Work

§ 5.2.1 Unless otherwise stated in the Contract Documents, the Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the persons or entities proposed for each principal portion of the Work, including those who are to furnish materials or equipment fabricated to a special design. Within 14 days of receipt of the information, the Architect may notify the Contractor whether the Owner or the Architect (1) has reasonable objection to any such proposed person or entity or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 5.2.2 The Contractor shall not contract with a proposed person or entity to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

§ 5.2.3 If the Owner or Architect has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Architect has no reasonable objection. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, the Contract Sum and Contract Time shall be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor's Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

§ 5.2.4 The Contractor shall not substitute a Subcontractor, person, or entity for one previously selected if the Owner or Architect makes reasonable objection to such substitution.

§ 5.3 Subcontractual Relations

By appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work that the Contractor, by these Contract Documents, assumes toward the Owner and Architect. Each subcontract agreement shall preserve and protect the rights of the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 5.4 Contingent Assignment of Subcontracts

§ 5.4.1 Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that

- **.1** assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor; and
- **.2** assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

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When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract.

§ 5.4.2 Upon such assignment, if the Work has been suspended for more than 30 days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension.

§ 5.4.3 Upon assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

§ 6.1 Owner's Right to Perform Construction and to Award Separate Contracts

§ 6.1.1 The term "Separate Contractor(s)" shall mean other contractors retained by the Owner under separate agreements. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and with Separate Contractors retained under Conditions of the Contract substantially similar to those of this Contract, including those provisions of the Conditions of the Contract related to insurance and waiver of subrogation.

§ 6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

§ 6.1.3 The Owner shall provide for coordination of the activities of the Owner's own forces and of each Separate Contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with any Separate Contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to its construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, Separate Contractors, and the Owner until subsequently revised.

§ 6.1.4 Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces or with Separate Contractors, the Owner or its Separate Contractors shall have the same obligations and rights that the Contractor has under the Conditions of the Contract, including, without excluding others, those stated in Article 3, this Article 6, and Articles 10, 11, and 12.

§ 6.2 Mutual Responsibility

§ 6.2.1 The Contractor shall afford the Owner and Separate Contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

§ 6.2.2 If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a Separate Contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly notify the Architect of apparent discrepancies or defects in the construction or operations by the Owner or Separate Contractor that would render it unsuitable for proper execution and results of the Contractor's Work. Failure of the Contractor to notify the Architect of apparent discrepancies or defects prior to proceeding with the Work shall constitute an acknowledgment that the Owner's or Separate Contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work. The Contractor shall not be responsible for discrepancies or defects in the construction or operations by the Owner or Separate Contractor that are not apparent.

§ 6.2.3 The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a Separate Contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a Separate Contractor's delays, improperly timed activities, damage to the Work or defective construction.

§ 6.2.4 The Contractor shall promptly remedy damage that the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or Separate Contractor as provided in Section 10.2.5.

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§ 6.2.5 The Owner and each Separate Contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

§ 6.3 Owner's Right to Clean Up

If a dispute arises among the Contractor, Separate Contractors, and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and the Architect will allocate the cost among those responsible.

ARTICLE 7 CHANGES IN THE WORK

§ 7.1 General

§ 7.1.1 Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

§ 7.1.2 A Change Order shall be based upon agreement among the Owner, Contractor, and Architect. A Construction Change Directive requires agreement by the Owner and Architect and may or may not be agreed to by the Contractor. An order for a minor change in the Work may be issued by the Architect alone.

§ 7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents. The Contractor shall proceed promptly with changes in the Work, unless otherwise provided in the Change Order, Construction Change Directive, or order for a minor change in the Work.

§ 7.2 Change Orders

§ 7.2.1 A Change Order is a written instrument prepared by the Architect and signed by the Owner, Contractor, and Architect stating their agreement upon all of the following:

- **.1** The change in the Work;
- **.2** The amount of the adjustment, if any, in the Contract Sum; and
- **.3** The extent of the adjustment, if any, in the Contract Time.

§ 7.3 Construction Change Directives

§ 7.3.1 A Construction Change Directive is a written order prepared by the Architect and signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

§ 7.3.2 A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

§ 7.3.3 If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

- **.1** Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
- **.2** Unit prices stated in the Contract Documents or subsequently agreed upon;
- **.3** Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
- **.4** As provided in Section 7.3.4.

§ 7.3.4 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.4 shall be limited to the following:

- **.1** Costs of labor, including applicable payroll taxes, fringe benefits required by agreement or custom, workers' compensation insurance, and other employee costs approved by the Architect;

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.2 Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;

.3 Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;

.4 Costs of premiums for all bonds and insurance, permit fees, and sales, use, or similar taxes, directly related to the change; and

.5 Costs of supervision and field office personnel directly attributable to the change.

§ 7.3.5 If the Contractor disagrees with the adjustment in the Contract Time, the Contractor may make a Claim in accordance with applicable provisions of Article 15.

§ 7.3.6 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Architect of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

§ 7.3.7 A Construction Change Directive signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

§ 7.3.8 The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Architect. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

§ 7.3.9 Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The Architect will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Architect determines, in the Architect's professional judgment, to be reasonably justified. The Architect's interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Article 15.

§ 7.3.10 When the Owner and Contractor agree with a determination made by the Architect concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Architect will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

§ 7.4 Minor Changes in the Work

The Architect may order minor changes in the Work that are consistent with the intent of the Contract Documents and do not involve an adjustment in the Contract Sum or an extension of the Contract Time. The Architect's order for minor changes shall be in writing. If the Contractor believes that the proposed minor change in the Work will affect the Contract Sum or Contract Time, the Contractor shall notify the Architect and shall not proceed to implement the change in the Work. If the Contractor performs the Work set forth in the Architect's order for a minor change without prior notice to the Architect that such change will affect the Contract Sum or Contract Time, the Contractor waives any adjustment to the Contract Sum or extension of the Contract Time.

ARTICLE 8 TIME

§ 8.1 Definitions

§ 8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

§ 8.1.2 The date of commencement of the Work is the date established in the Agreement.

§ 8.1.3 The date of Substantial Completion is the date certified by the Architect in accordance with Section 9.8.

§ 8.1.4 The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

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§ 8.2 Progress and Completion

§ 8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

§ 8.2.2 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, commence the Work prior to the effective date of insurance required to be furnished by the Contractor and Owner.

§ 8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

§ 8.3 Delays and Extensions of Time

§ 8.3.1 If the Contractor is delayed at any time in the commencement or progress of the Work by (1) an act or neglect of the Owner or Architect, of an employee of either, or of a Separate Contractor; (2) by changes ordered in the Work; (3) by labor disputes, fire, unusual delay in deliveries, unavoidable casualties, adverse weather conditions documented in accordance with Section 15.1.6.2, or other causes beyond the Contractor's control; (4) by delay authorized by the Owner pending mediation and binding dispute resolution; or (5) by other causes that the Contractor asserts, and the Architect determines, justify delay, then the Contract Time shall be extended for such reasonable time as the Architect may determine.

§ 8.3.2 Claims relating to time shall be made in accordance with applicable provisions of Article 15.

§ 8.3.3 This Section 8.3 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 Contract Sum

§ 9.1.1 The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

§ 9.1.2 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed so that application of such unit prices to the actual quantities causes substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

§ 9.2 Schedule of Values

Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit a schedule of values to the Architect before the first Application for Payment, allocating the entire Contract Sum to the various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Architect. This schedule, unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Architect and supported by such data to substantiate its accuracy as the Architect may require, and unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

§ 9.3 Applications for Payment

§ 9.3.1 At least ten days before the date established for each progress payment, the Contractor shall submit to the Architect an itemized Application for Payment prepared in accordance with the schedule of values, if required under Section 9.2, for completed portions of the Work. The application shall be notarized, if required, and supported by all data substantiating the Contractor's right to payment that the Owner or Architect require, such as copies of requisitions, and releases and waivers of liens from Subcontractors and suppliers, and shall reflect retainage if provided for in the Contract Documents.

§ 9.3.1.1 As provided in Section 7.3.9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included in Change Orders.

§ 9.3.1.2 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or supplier, unless such Work has been performed by others whom the Contractor intends to pay.

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§ 9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage, and transportation to the site, for such materials and equipment stored off the site.

§ 9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information, and belief, be free and clear of liens, claims, security interests, or encumbrances, in favor of the Contractor, Subcontractors, suppliers, or other persons or entities that provided labor, materials, and equipment relating to the Work.

§ 9.4 Certificates for Payment

§ 9.4.1 The Architect will, within seven days after receipt of the Contractor's Application for Payment, either (1) issue to the Owner a Certificate for Payment in the full amount of the Application for Payment, with a copy to the Contractor; or (2) issue to the Owner a Certificate for Payment for such amount as the Architect determines is properly due, and notify the Contractor and Owner of the Architect's reasons for withholding certification in part as provided in Section 9.5.1; or (3) withhold certification of the entire Application for Payment, and notify the Contractor and Owner of the Architect's reason for withholding certification in whole as provided in Section 9.5.1.

§ 9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data in the Application for Payment, that, to the best of the Architect's knowledge, information, and belief, the Work has progressed to the point indicated, the quality of the Work is in accordance with the Contract Documents, and that the Contractor is entitled to payment in the amount certified. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion, and to specific qualifications expressed by the Architect. However, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences, or procedures; (3) reviewed copies of requisitions received from Subcontractors and suppliers and other data requested by the Owner to substantiate the Contractor's right to payment; or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

§ 9.5 Decisions to Withhold Certification

§ 9.5.1 The Architect may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Architect's opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Architect is unable to certify payment in the amount of the Application, the Architect will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Architect cannot agree on a revised amount, the Architect will promptly issue a Certificate for Payment for the amount for which the Architect is able to make such representations to the Owner. The Architect may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Architect's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of

- **.1** defective Work not remedied;
- **.2** third party claims filed or reasonable evidence indicating probable filing of such claims, unless security acceptable to the Owner is provided by the Contractor;
- **.3** failure of the Contractor to make payments properly to Subcontractors or suppliers for labor, materials or equipment;
- **.4** reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- **.5** damage to the Owner or a Separate Contractor;
- **.6** reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay; or

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.7 repeated failure to carry out the Work in accordance with the Contract Documents.

§ 9.5.2 When either party disputes the Architect's decision regarding a Certificate for Payment under Section 9.5.1, in whole or in part, that party may submit a Claim in accordance with Article 15.

§ 9.5.3 When the reasons for withholding certification are removed, certification will be made for amounts previously withheld.

§ 9.5.4 If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or supplier to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Architect and the Contractor shall reflect such payment on its next Application for Payment.

§ 9.6 Progress Payments

§ 9.6.1 After the Architect has issued a Certificate for Payment, the Owner shall make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Architect.

§ 9.6.2 The Contractor shall pay each Subcontractor, no later than seven days after receipt of payment from the Owner, the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

§ 9.6.3 The Architect will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Architect and Owner on account of portions of the Work done by such Subcontractor.

§ 9.6.4 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors and suppliers to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay, or to see to the payment of money to, a Subcontractor or supplier, except as may otherwise be required by law.

§ 9.6.5 The Contractor's payments to suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.

§ 9.6.6 A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

§ 9.6.7 Unless the Contractor provides the Owner with a payment bond in the full penal sum of the Contract Sum, payments received by the Contractor for Work properly performed by Subcontractors or provided by suppliers shall be held by the Contractor for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with the Contractor for which payment was made by the Owner. Nothing contained herein shall require money to be placed in a separate account and not commingled with money of the Contractor, create any fiduciary liability or tort liability on the part of the Contractor for breach of trust, or entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

§ 9.6.8 Provided the Owner has fulfilled its payment obligations under the Contract Documents, the Contractor shall defend and indemnify the Owner from all loss, liability, damage or expense, including reasonable attorney's fees and litigation expenses, arising out of any lien claim or other claim for payment by any Subcontractor or supplier of any tier. Upon receipt of notice of a lien claim or other claim for payment, the Owner shall notify the Contractor. If approved by the applicable court, when required, the Contractor may substitute a surety bond for the property against which the lien or other claim for payment has been asserted.

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§ 9.7 Failure of Payment

If the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within seven days after the date established in the Contract Documents, the amount certified by the Architect or awarded by binding dispute resolution, then the Contractor may, upon seven additional days' notice to the Owner and Architect, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided for in the Contract Documents.

§ 9.8 Substantial Completion

§ 9.8.1 Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.

§ 9.8.2 When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

§ 9.8.3 Upon receipt of the Contractor's list, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Architect. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

§ 9.8.4 When the Work or designated portion thereof is substantially complete, the Architect will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion; establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance; and fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate. Upon such acceptance, and consent of surety if any, the Owner shall make payment of retainage applying to the Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

§ 9.9 Partial Occupancy or Use

§ 9.9.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Architect as provided under Section 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Architect.

§ 9.9.2 Immediately prior to such partial occupancy or use, the Owner, Contractor, and Architect shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

§ 9.9.3 Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

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§ 9.10 Final Completion and Final Payment

§ 9.10.1 Upon receipt of the Contractor's notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect will promptly make such inspection. When the Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance with the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

§ 9.10.2 Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect, (3) a written statement that the Contractor knows of no reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety, if any, to final payment, (5) documentation of any special warranties, such as manufacturers' warranties or specific Subcontractor warranties, and (6) if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts and releases and waivers of liens, claims, security interests, or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien, claim, security interest, or encumbrance. If a lien, claim, security interest, or encumbrance remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging the lien, claim, security interest, or encumbrance, including all costs and reasonable attorneys' fees.

§ 9.10.3 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Architect so confirms, the Owner shall, upon application by the Contractor and certification by the Architect, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed, corrected, and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of the surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Architect prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

§ 9.10.4 The making of final payment shall constitute a waiver of Claims by the Owner except those arising from

- **.1** liens, Claims, security interests, or encumbrances arising out of the Contract and unsettled;
- **.2** failure of the Work to comply with the requirements of the Contract Documents;
- **.3** terms of special warranties required by the Contract Documents; or
- **.4** audits performed by the Owner, if permitted by the Contract Documents, after final payment.

§ 9.10.5 Acceptance of final payment by the Contractor, a Subcontractor, or a supplier, shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

§ 10.1 Safety Precautions and Programs

The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Contract.

§ 10.2 Safety of Persons and Property

§ 10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury, or loss to

- **.1** employees on the Work and other persons who may be affected thereby;

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.2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor, a Subcontractor, or a Sub-subcontractor; and

.3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

§ 10.2.2 The Contractor shall comply with, and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities, bearing on safety of persons or property or their protection from damage, injury, or loss.

§ 10.2.3 The Contractor shall implement, erect, and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards; promulgating safety regulations; and notifying the owners and users of adjacent sites and utilities of the safeguards.

§ 10.2.4 When use or storage of explosives or other hazardous materials or equipment, or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel.

§ 10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3. The Contractor may make a Claim for the cost to remedy the damage or loss to the extent such damage or loss is attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

§ 10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Architect.

§ 10.2.7 The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

§ 10.2.8 Injury or Damage to Person or Property

If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, notice of the injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding 21 days after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter.

§ 10.3 Hazardous Materials and Substances

§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials or substances. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and notify the Owner and Architect of the condition.

§ 10.3.2 Upon receipt of the Contractor's notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Architect the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of the material or substance or who are to perform the task of removal or safe containment of the material or substance. The Contractor and the Architect will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed

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by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable additional costs of shutdown, delay, and start-up.

§ 10.3.3 To the fullest extent permitted by law, the Owner shall indemnify and hold harmless the Contractor, Subcontractors, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance presents the risk of bodily injury or death as described in Section 10.3.1 and has not been rendered harmless, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), except to the extent that such damage, loss, or expense is due to the fault or negligence of the party seeking indemnity.

§ 10.3.4 The Owner shall not be responsible under this Section 10.3 for hazardous materials or substances the Contractor brings to the site unless such materials or substances are required by the Contract Documents. The Owner shall be responsible for hazardous materials or substances required by the Contract Documents, except to the extent of the Contractor's fault or negligence in the use and handling of such materials or substances.

§ 10.3.5 The Contractor shall reimburse the Owner for the cost and expense the Owner incurs (1) for remediation of hazardous materials or substances the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1, except to the extent that the cost and expense are due to the Owner's fault or negligence.

§ 10.3.6 If, without negligence on the part of the Contractor, the Contractor is held liable by a government agency for the cost of remediation of a hazardous material or substance solely by reason of performing Work as required by the Contract Documents, the Owner shall reimburse the Contractor for all cost and expense thereby incurred.

§ 10.4 Emergencies

In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury, or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7.

ARTICLE 11 INSURANCE AND BONDS

§ 11.1 Contractor's Insurance and Bonds

§ 11.1.1 The Contractor shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Contractor shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located. The Owner, Architect, and Architect's consultants shall be named as additional insureds under the Contractor's commercial general liability policy or as otherwise described in the Contract Documents.

§ 11.1.2 The Contractor shall provide surety bonds of the types, for such penal sums, and subject to such terms and conditions as required by the Contract Documents. The Contractor shall purchase and maintain the required bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 11.1.3 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

§ 11.1.4 Notice of Cancellation or Expiration of Contractor's Required Insurance. Within three (3) business days of the date the Contractor becomes aware of an impending or actual cancellation or expiration of any insurance required by the Contract Documents, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration. Upon receipt of notice from the Contractor, the Owner shall, unless the lapse in coverage arises from an act or omission of the Owner, have the right to stop the Work until the lapse in coverage has been cured by the

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procurement of replacement coverage by the Contractor. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage.

§ 11.2 Owner's Insurance

§ 11.2.1 The Owner shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Owner shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located.

§ 11.2.2 Failure to Purchase Required Property Insurance. If the Owner fails to purchase and maintain the required property insurance, with all of the coverages and in the amounts described in the Agreement or elsewhere in the Contract Documents, the Owner shall inform the Contractor in writing prior to commencement of the Work. Upon receipt of notice from the Owner, the Contractor may delay commencement of the Work and may obtain insurance that will protect the interests of the Contractor, Subcontractors, and Sub-Subcontractors in the Work. When the failure to provide coverage has been cured or resolved, the Contract Sum and Contract Time shall be equitably adjusted. In the event the Owner fails to procure coverage, the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent the loss to the Owner would have been covered by the insurance to have been procured by the Owner. The cost of the insurance shall be charged to the Owner by a Change Order. If the Owner does not provide written notice, and the Contractor is damaged by the failure or neglect of the Owner to purchase or maintain the required insurance, the Owner shall reimburse the Contractor for all reasonable costs and damages attributable thereto.

§ 11.2.3 Notice of Cancellation or Expiration of Owner's Required Property Insurance. Within three (3) business days of the date the Owner becomes aware of an impending or actual cancellation or expiration of any property insurance required by the Contract Documents, the Owner shall provide notice to the Contractor of such impending or actual cancellation or expiration. Unless the lapse in coverage arises from an act or omission of the Contractor: (1) the Contractor, upon receipt of notice from the Owner, shall have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by either the Owner or the Contractor; (2) the Contract Time and Contract Sum shall be equitably adjusted; and (3) the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent any loss to the Owner would have been covered by the insurance had it not expired or been cancelled. If the Contractor purchases replacement coverage, the cost of the insurance shall be charged to the Owner by an appropriate Change Order. The furnishing of notice by the Owner shall not relieve the Owner of any contractual obligation to provide required insurance.

§ 11.3 Waivers of Subrogation

§ 11.3.1 The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents, and employees, each of the other; (2) the Architect and Architect's consultants; and (3) Separate Contractors, if any, and any of their subcontractors, sub-subcontractors, agents, and employees, for damages caused by fire, or other causes of loss, to the extent those losses are covered by property insurance required by the Agreement or other property insurance applicable to the Project, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require similar written waivers in favor of the individuals and entities identified above from the Architect, Architect's consultants, Separate Contractors, subcontractors, and sub-subcontractors. The policies of insurance purchased and maintained by each person or entity agreeing to waive claims pursuant to this section 11.3.1 shall not prohibit this waiver of subrogation. This waiver of subrogation shall be effective as to a person or entity (1) even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, (2) even though that person or entity did not pay the insurance premium directly or indirectly, or (3) whether or not the person or entity had an insurable interest in the damaged property.

§ 11.3.2 If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring the Project during the construction period, to the extent permissible by such policies, the Owner waives all rights in accordance with the terms of Section 11.3.1 for damages caused by fire or other causes of loss covered by this separate property insurance.

§ 11.4 Loss of Use, Business Interruption, and Delay in Completion Insurance

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The Owner, at the Owner's option, may purchase and maintain insurance that will protect the Owner against loss of use of the Owner's property, or the inability to conduct normal operations, due to fire or other causes of loss. The Owner waives all rights of action against the Contractor and Architect for loss of use of the Owner's property, due to fire or other hazards however caused.

§11.5 Adjustment and Settlement of Insured Loss

§ 11.5.1 A loss insured under the property insurance required by the Agreement shall be adjusted by the Owner as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.5.2. The Owner shall pay the Architect and Contractor their just shares of insurance proceeds received by the Owner, and by appropriate agreements the Architect and Contractor shall make payments to their consultants and Subcontractors in similar manner.

§ 11.5.2 Prior to settlement of an insured loss, the Owner shall notify the Contractor of the terms of the proposed settlement as well as the proposed allocation of the insurance proceeds. The Contractor shall have 14 days from receipt of notice to object to the proposed settlement or allocation of the proceeds. If the Contractor does not object, the Owner shall settle the loss and the Contractor shall be bound by the settlement and allocation. Upon receipt, the Owner shall deposit the insurance proceeds in a separate account and make the appropriate distributions. Thereafter, if no other agreement is made or the Owner does not terminate the Contract for convenience, the Owner and Contractor shall execute a Change Order for reconstruction of the damaged or destroyed Work in the amount allocated for that purpose. If the Contractor timely objects to either the terms of the proposed settlement or the allocation of the proceeds, the Owner may proceed to settle the insured loss, and any dispute between the Owner and Contractor arising out of the settlement or allocation of the proceeds shall be resolved pursuant to Article 15. Pending resolution of any dispute, the Owner may issue a Construction Change Directive for the reconstruction of the damaged or destroyed Work.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ 12.1 Uncovering of Work

§ 12.1.1 If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the Contract Documents, it must, if requested in writing by the Architect, be uncovered for the Architect's examination and be replaced at the Contractor's expense without change in the Contract Time.

§ 12.1.2 If a portion of the Work has been covered that the Architect has not specifically requested to examine prior to its being covered, the Architect may request to see such Work and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, the Contractor shall be entitled to an equitable adjustment to the Contract Sum and Contract Time as may be appropriate. If such Work is not in accordance with the Contract Documents, the costs of uncovering the Work, and the cost of correction, shall be at the Contractor's expense.

§ 12.2 Correction of Work

§ 12.2.1 Before Substantial Completion

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, discovered before Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.

§ 12.2.2 After Substantial Completion

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. During the one-year period for correction of Work, if the Owner fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner waives the rights to require correction by the Contractor and to make a claim for breach of warranty. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.5.

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§ 12.2.2.2 The one-year period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

§ 12.2.2.3 The one-year period for correction of Work shall not be extended by corrective Work performed by the Contractor pursuant to this Section 12.2.

§ 12.2.3 The Contractor shall remove from the site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

§ 12.2.4 The Contractor shall bear the cost of correcting destroyed or damaged construction of the Owner or Separate Contractors, whether completed or partially completed, caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

§ 12.2.5 Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

§ 12.3 Acceptance of Nonconforming Work

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ 13.1 Governing Law

The Contract shall be governed by the law of the place where the Project is located, excluding that jurisdiction's choice of law rules. If the parties have selected arbitration as the method of binding dispute resolution, the Federal Arbitration Act shall govern Section 15.4.

§ 13.2 Successors and Assigns

§ 13.2.1 The Owner and Contractor respectively bind themselves, their partners, successors, assigns, and legal representatives to covenants, agreements, and obligations contained in the Contract Documents. Except as provided in Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

§ 13.2.2 The Owner may, without consent of the Contractor, assign the Contract to a lender providing construction financing for the Project, if the lender assumes the Owner's rights and obligations under the Contract Documents. The Contractor shall execute all consents reasonably required to facilitate the assignment.

§ 13.3 Rights and Remedies

§ 13.3.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

§ 13.3.2 No action or failure to act by the Owner, Architect, or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed upon in writing.

§ 13.4 Tests and Inspections

§ 13.4.1 Tests, inspections, and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules, and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections, and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections, and approvals. The Contractor shall give the Architect

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timely notice of when and where tests and inspections are to be made so that the Architect may be present for such procedures. The Owner shall bear costs of tests, inspections, or approvals that do not become requirements until after bids are received or negotiations concluded. The Owner shall directly arrange and pay for tests, inspections, or approvals where building codes or applicable laws or regulations so require.

§ 13.4.2 If the Architect, Owner, or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection, or approval not included under Section 13.4.1, the Architect will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection, or approval, by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Architect of when and where tests and inspections are to be made so that the Architect may be present for such procedures. Such costs, except as provided in Section 13.4.3, shall be at the Owner's expense.

§ 13.4.3 If procedures for testing, inspection, or approval under Sections 13.4.1 and 13.4.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure, including those of repeated procedures and compensation for the Architect's services and expenses, shall be at the Contractor's expense.

§ 13.4.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Architect.

§ 13.4.5 If the Architect is to observe tests, inspections, or approvals required by the Contract Documents, the Architect will do so promptly and, where practicable, at the normal place of testing.

§ 13.4.6 Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

§ 13.5 Interest

Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at the rate the parties agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ 14.1 Termination by the Contractor

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 30 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, for any of the following reasons:

- **.1** Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;
- **.2** An act of government, such as a declaration of national emergency, that requires all Work to be stopped;
- **.3** Because the Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the Owner has not made payment on a Certificate for Payment within the time stated in the Contract Documents; or
- **.4** The Owner has failed to furnish to the Contractor reasonable evidence as required by Section 2.2.

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, repeated suspensions, delays, or interruptions of the entire Work by the Owner as described in Section 14.3, constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

§ 14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, as well as reasonable overhead and profit on Work not executed, and costs incurred by reason of such termination.

§ 14.1.4 If the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, or their agents or employees or any other persons or entities performing portions of the Work because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract

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Documents with respect to matters important to the progress of the Work, the Contractor may, upon seven additional days' notice to the Owner and the Architect, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

§ 14.2 Termination by the Owner for Cause

§ 14.2.1 The Owner may terminate the Contract if the Contractor

- **.1** repeatedly refuses or fails to supply enough properly skilled workers or proper materials;
- **.2** fails to make payment to Subcontractors or suppliers in accordance with the respective agreements between the Contractor and the Subcontractors or suppliers;
- **.3** repeatedly disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority; or
- **.4** otherwise is guilty of substantial breach of a provision of the Contract Documents.

§ 14.2.2 When any of the reasons described in Section 14.2.1 exist, and upon certification by the Architect that sufficient cause exists to justify such action, the Owner may, without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, seven days' notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

- **.1** Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
- **.2** Accept assignment of subcontracts pursuant to Section 5.4; and
- **.3** Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

§ 14.2.3 When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

§ 14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ 14.3 Suspension by the Owner for Convenience

§ 14.3.1 The Owner may, without cause, order the Contractor in writing to suspend, delay or interrupt the Work, in whole or in part for such period of time as the Owner may determine.

§ 14.3.2 The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay, or interruption under Section 14.3.1. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

- **.1** that performance is, was, or would have been, so suspended, delayed, or interrupted, by another cause for which the Contractor is responsible; or
- **.2** that an equitable adjustment is made or denied under another provision of the Contract.

§ 14.4 Termination by the Owner for Convenience

§ 14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

§ 14.4.2 Upon receipt of notice from the Owner of such termination for the Owner's convenience, the Contractor shall

- **.1** cease operations as directed by the Owner in the notice;
- **.2** take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and
- **.3** except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

§ 14.4.3 In case of such termination for the Owner's convenience, the Owner shall pay the Contractor for Work

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properly executed; costs incurred by reason of the termination, including costs attributable to termination of Subcontracts; and the termination fee, if any, set forth in the Agreement.

ARTICLE 15 CLAIMS AND DISPUTES

§ 15.1 Claims

§ 15.1.1 Definition

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, a change in the Contract Time, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim. This Section 15.1.1 does not require the Owner to file a Claim in order to impose liquidated damages in accordance with the Contract Documents.

§ 15.1.2 Time Limits on Claims

The Owner and Contractor shall commence all Claims and causes of action against the other and arising out of or related to the Contract, whether in contract, tort, breach of warranty or otherwise, in accordance with the requirements of the binding dispute resolution method selected in the Agreement and within the period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all Claims and causes of action not commenced in accordance with this Section 15.1.2.

§ 15.1.3 Notice of Claims

§ 15.1.3.1 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered prior to expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party and to the Initial Decision Maker with a copy sent to the Architect, if the Architect is not serving as the Initial Decision Maker. Claims by either party under this Section 15.1.3.1 shall be initiated within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

§ 15.1.3.2 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party. In such event, no decision by the Initial Decision Maker is required.

§ 15.1.4 Continuing Contract Performance

§ 15.1.4.1 Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents.

§ 15.1.4.2 The Contract Sum and Contract Time shall be adjusted in accordance with the Initial Decision Maker's decision, subject to the right of either party to proceed in accordance with this Article 15. The Architect will issue Certificates for Payment in accordance with the decision of the Initial Decision Maker.

§ 15.1.5 Claims for Additional Cost

If the Contractor wishes to make a Claim for an increase in the Contract Sum, notice as provided in Section 15.1.3 shall be given before proceeding to execute the portion of the Work that is the subject of the Claim. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

§ 15.1.6 Claims for Additional Time

§ 15.1.6.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, notice as provided in Section 15.1.3 shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary.

§ 15.1.6.2 If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated, and had an adverse effect on the scheduled construction.

§ 15.1.7 Waiver of Claims for Consequential Damages

The Contractor and Owner waive Claims against each other for consequential damages arising out of or relating to this Contract. This mutual waiver includes

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.1 damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and

.2 damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit, except anticipated profit arising directly from the Work.

This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination in accordance with Article 14. Nothing contained in this Section 15.1.7 shall be deemed to preclude assessment of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

§ 15.2 Initial Decision

§ 15.2.1 Claims, excluding those where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2 or arising under Sections 10.3, 10.4, and 11.5, shall be referred to the Initial Decision Maker for initial decision. The Architect will serve as the Initial Decision Maker, unless otherwise indicated in the Agreement. Except for those Claims excluded by this Section 15.2.1, an initial decision shall be required as a condition precedent to mediation of any Claim. If an initial decision has not been rendered within 30 days after the Claim has been referred to the Initial Decision Maker, the party asserting the Claim may demand mediation and binding dispute resolution without a decision having been rendered. Unless the Initial Decision Maker and all affected parties agree, the Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

§ 15.2.2 The Initial Decision Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Decision Maker concludes that, in the Initial Decision Maker's sole discretion, it would be inappropriate for the Initial Decision Maker to resolve the Claim.

§ 15.2.3 In evaluating Claims, the Initial Decision Maker may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Initial Decision Maker in rendering a decision. The Initial Decision Maker may request the Owner to authorize retention of such persons at the Owner's expense.

§ 15.2.4 If the Initial Decision Maker requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of the request, and shall either (1) provide a response on the requested supporting data, (2) advise the Initial Decision Maker when the response or supporting data will be furnished, or (3) advise the Initial Decision Maker that no supporting data will be furnished. Upon receipt of the response or supporting data, if any, the Initial Decision Maker will either reject or approve the Claim in whole or in part.

§ 15.2.5 The Initial Decision Maker will render an initial decision approving or rejecting the Claim, or indicating that the Initial Decision Maker is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Architect, if the Architect is not serving as the Initial Decision Maker, of any change in the Contract Sum or Contract Time or both. The initial decision shall be final and binding on the parties but subject to mediation and, if the parties fail to resolve their dispute through mediation, to binding dispute resolution.

§ 15.2.6 Either party may file for mediation of an initial decision at any time, subject to the terms of Section 15.2.6.1.

§ 15.2.6.1 Either party may, within 30 days from the date of receipt of an initial decision, demand in writing that the other party file for mediation. If such a demand is made and the party receiving the demand fails to file for mediation within 30 days after receipt thereof, then both parties waive their rights to mediate or pursue binding dispute resolution proceedings with respect to the initial decision.

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§ 15.2.7 In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

§ 15.2.8 If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

§ 15.3 Mediation

§ 15.3.1 Claims, disputes, or other matters in controversy arising out of or related to the Contract, except those waived as provided for in Sections 9.10.4, 9.10.5, and 15.1.7, shall be subject to mediation as a condition precedent to binding dispute resolution.

§ 15.3.2 The parties shall endeavor to resolve their Claims by mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement. A request for mediation shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the mediation. The request may be made concurrently with the filing of binding dispute resolution proceedings but, in such event, mediation shall proceed in advance of binding dispute resolution proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order. If an arbitration is stayed pursuant to this Section 15.3.2, the parties may nonetheless proceed to the selection of the arbitrator(s) and agree upon a schedule for later proceedings.

§ 15.3.3 Either party may, within 30 days from the date that mediation has been concluded without resolution of the dispute or 60 days after mediation has been demanded without resolution of the dispute, demand in writing that the other party file for binding dispute resolution. If such a demand is made and the party receiving the demand fails to file for binding dispute resolution within 60 days after receipt thereof, then both parties waive their rights to binding dispute resolution proceedings with respect to the initial decision.

§ 15.3.4 The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the Project is located, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

§ 15.4 Arbitration

§ 15.4.1 If the parties have selected arbitration as the method for binding dispute resolution in the Agreement, any Claim subject to, but not resolved by, mediation shall be subject to arbitration which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules in effect on the date of the Agreement. The Arbitration shall be conducted in the place where the Project is located, unless another location is mutually agreed upon. A demand for arbitration shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the arbitration. The party filing a notice of demand for arbitration must assert in the demand all Claims then known to that party on which arbitration is permitted to be demanded.

§ 15.4.1.1 A demand for arbitration shall be made no earlier than concurrently with the filing of a request for mediation, but in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the applicable statute of limitations. For statute of limitations purposes, receipt of a written demand for arbitration by the person or entity administering the arbitration shall constitute the institution of legal or equitable proceedings based on the Claim.

§ 15.4.2 The award rendered by the arbitrator or arbitrators shall be final, and judgment may be entered upon it in accordance with applicable law in any court having jurisdiction thereof.

§ 15.4.3 The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by parties to the Agreement, shall be specifically enforceable under applicable law in any court having jurisdiction thereof.

§ 15.4.4 Consolidation or Joinder

§ 15.4.4.1 Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may consolidate an arbitration conducted under this Agreement with any other arbitration to which it is a party

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provided that (1) the arbitration agreement governing the other arbitration permits consolidation, (2) the arbitrations to be consolidated substantially involve common questions of law or fact, and (3) the arbitrations employ materially similar procedural rules and methods for selecting arbitrator(s).

§ 15.4.4.2 Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may include by joinder persons or entities substantially involved in a common question of law or fact whose presence is required if complete relief is to be accorded in arbitration, provided that the party sought to be joined consents in writing to such joinder. Consent to arbitration involving an additional person or entity shall not constitute consent to arbitration of any claim, dispute or other matter in question not described in the written consent.

§ 15.4.4.3 The Owner and Contractor grant to any person or entity made a party to an arbitration conducted under this Section 15.4, whether by joinder or consolidation, the same rights of joinder and consolidation as those of the Owner and Contractor under this Agreement.

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GENERAL CONDITIONS

The Work of this Contract shall be subject to the American Institute of Architects Document A201, "General Conditions of the Contract for Construction", herein referred to as the General Conditions.

SUPPLEMENTARY CONDITIONS

The supplementary Conditions contain changes and additions to the General Conditions. Where any part of the General Conditions is modified or voided by the Supplementary Conditions, the remaining unaltered provisions shall remain in effect.

ARTICLE 1 **Make the following changes**:

1.2.3 **Add the following:** When applied to materials and equipment required for the Work, the words "furnish", "install" and "provide" shall mean the following:

.1 The word "provide" shall mean to furnish, pay for, deliver, install, adjust, clean, and otherwise make materials and equipment fit and ready for their intended use.
.2 The word "furnish" shall mean to secure, pay for, deliver to site, unload, and uncrate materials and equipment.
.3 The word "install" shall mean to place in position, incorporate in the work, adjust, clean, make fit and ready for use and perform all services except those included under the term "furnish".
.4 The phrase "furnish and install" shall be equivalent to the word "provide". Each shall be interpreted to mean "the Contractor shall furnish all labor, material and equipment and install....".
.5 “As required" shall mean as required to produce a fully completed project or result to the satisfaction of the Architect.
.6 Where discrepancies or conflicts occur:

.1 Amendments and Addenda shall take precedence over the Specifications.
.2 The Specifications shall take precedence over the Drawings.
.3 Stated dimensions shall take precedence over scaled dimensions.
.4 Large-scale detail drawings shall take precedence over small-scale drawings.
.5 Schedules shall take precedence over other data on the drawings.

.7 In case of a difference between Drawings or Specifications or within either document itself in describing the Work, the <u>better quality, greater quantity, or costlier</u> work will be assumed to be and shall be included in the Contract price. The Contractor shall not proceed with such work until the Architect has been contacted for clarification and proper direction.
.8 Instructions or specifications of a particular manufacturer as referred to herein shall be binding as a part of this Specification. Obtain such written instructions and maintain on the job with the Specification.
.9 Schedules of materials in various sections of the Specifications are furnished to assist the Contractor. Contractor shall verify the schedules with the Drawings and shall provide any additional materials indicated on the Drawings but not included in the schedules. The greater quantity or highest quality will govern.

Add the following:

1.2.4 All work shown or referred to in the Contract Documents shall be included in the Contract excepting those items which are specifically noted as being "provided under another contract" or "provided by the Owner", or "not in contract (NIC)".

1.2.5 Parties to the Contract shall not take advantage of obvious error or apparent discrepancy in Contract Documents. Notice of discovered error or discrepancy shall immediately be given in writing to the Architect to make such corrections and interpretations as he may deem necessary for completion of the work in a satisfactory and acceptable manner.

ARTICLE 2 **Make the following changes:**

2.3.6 **Revise to read as follows:** "Contractor shall be furnished up to three (3) sets of Contract Drawings and Specifications, and two (2) copies of each drawing which is issued after the date of the Contract. The Contractor shall pay costs of reproduction for any additional copies of Drawings or Specifications he requires."

ARTICLE 3 **Make the following changes:**

Add the following:

3.4.4 Should the Contractor wish to substitute another product or method for products or methods specified or shown in the Contract Documents, whether specified or shown in Contract Documents, whether or not such phrases as "equal to" or "based on" are used, he shall apply in writing for approval. He shall enclose such data as Architect requires to evaluate products. The Architect's decision shall be final. Contractor is responsible for space requirements of substitutions, he shall execute necessary changes in adjacent and relocated situations, he shall execute necessary changes in adjacent and relocated work which are due to such substitutions, without additional cost and he shall be responsible for delays required for evaluation of proposed substitutions.

3.5.3 Project Warranty: Unless otherwise specified, Contractor shall warrant (guaranty) all work against defects resulting from the use of material, workmanship or equipment which is inferior, defective, or not in accordance with the terms of the Contract. This warranty, unless stated otherwise in a given section of the Specifications, shall be for a period of one (1) year from the date of issuance of the Certificate of Substantial Completion for the Project.

3.5.4 Specified Product Warranty: Issued by a manufacturer or fabricator for compliance with requirements of the Contract Documents. Refer to sections of Specifications for requirements of specified warranties.

3.5.5 Coincidental Product Warranty: Available on a product incorporated into the work, by virtue of manufacturer's publication of warranty without regard for application requirement, a non-specified warranty. Contractor shall identify such warranties as they apply.

3.5.6 Warranty Obligations

.1 Contractor shall restore or remove-and-replace warranted work to its originally specified condition, at such time during warranty as it does not comply with or fulfill terms of warranty.
.2 Contractor shall restore or remove-and-replace other work which has been damaged by failure of warranted work, or which must be removed and replaced to gain access to warranted work.
.3 Cost of restoration or removal-and-replacement is Contractor's obligation, without regard to whether Owner has already benefited from use of failing work.
.4 Except as otherwise indicated or required by governing regulations, warranties do not cover consequential damage to property other than the Work of the Contract.
.5 Upon restoration or removal-and-replacement of warranted work which has failed, Contractor shall reinstate the warranty by issuing newly executed form, for at least the

remaining period of time of the original warranty, but for not less than half of the original warranty period.

.6 Warranties and warranty periods shall not diminish implied warranties, and shall not deprive Owner of actions, rights, and remedies otherwise available if the Contractor fails to fulfill the requirements of the Contract Documents.

.7 Owner reserves the right to reject coincidental product warranties which conflict with or are less than the requirements of the Contract Documents.

3.5.7 Contractor shall furnish fully executed warranties to Owner in accordance with the General Conditions and Section 017700.

3.6 **Add the following:** No amount shall be included in the bid for State Sales Tax or for Federal Excise Tax on materials or supplies purchased for this project. The Owner will supply tax exempt number.

3.7.1 **Add the following:** The Contractor shall pay costs charged by utility companies for service connections, inspections and tests, and related utility company fees normally assessed as part of the construction process.

ARTICLE 4 **Make the following changes:**

4.2.13 Add to the first sentence, after "...relating to aesthetic effect..."

"and except for claims which have been waived by making or acceptance of final payment as provided by Subparagraphs 9.10.3 and 9.10.4,"

Add the following:

4.3 The provisions of Article 15 notwithstanding, the Contractor expressly agrees to joinder in arbitration proceedings between Owner/Architect upon specific written request of the Owner. This agreement shall be valid with the Architect's acceptance of an equal provision in their respective contracts.

ARTICLE 6 **Add the following:**

6.3.1 In a dispute between the Owner and the Contractor concerning rubbish and orderliness on the site, the Owner may have the rubbish removed and charge the cost to the Contractor. Upon written notification from the Architect that the project requires cleaning, the Contractor shall within 24 hours remove all rubbish and hazards from the project and shall arrange his material and equipment in an orderly manner on the site. If this cleaning is not completed within 24 hours, the Owner may engage labor to clean up the projects to his satisfaction and deduct the costs from any monies due the Contractor.

ARTICLE 7 **Add the following:**

7.2.2 The Contractor's proposal for changes in the Work shall be itemized completely and in detail and shall include material costs and quantities, labor wages, time, insurance, pensions, and equipment rental other than small tools, and the number of additional calendar days, if any, which are required to complete the Work.

Where unit prices have been established, the proposal shall state the quantity involved and the applicable unit price.

7.5 Allowance for Overhead and Profit

7.5.1 The allowance for overhead and profit is compensation for administration, superintendence, materials for temporary structures, additional premiums on bonds and the use of small tools.

7.5.2 For additions, deletions or other changes in the Work ordered under method 7.3.3.3, the Contractor may apply an allowance of up to fifteen percent (15%) for profit and overhead to the net cost of the work actually performed by him.

7.5.3 Work to be performed by a subcontractor may include an allowance for the subcontractor's overhead and profit not to exceed ten percent (10%) of the net cost. The Contractor is permitted up to a **five percent (5%)** allowance to be applied against the net cost to a subcontractor. In no case shall the total allowance exceed fifteen percent (15%) of the net cost of work performed by the subcontractor.

7.5.4 The Contractor's allowance of up to ten percent (10%) on changes involving more than one (1) subcontractor shall be applied only to the combined net of cost additions and deductions of all subcontractors.

7.5.5 There shall be no allowance for overhead and profit for the Contractor or any subcontractor on changes resulting in a net deduction.

7.5.6 The provisions of this Article shall apply only to subcontractors as defined in Article 5. Allowance for overhead and profit will be accepted only for those who are direct subcontractors.

ARTICLE 8 **Add the following:**

8.3.4 No extension of time will be allowed for adverse weather conditions unless the number of days of inclement weather is substantially greater or conditions substantially more severe than the average for the calendar period as recorded by a recognized weather observation agency.

ARTICLE 9 **Make the following changes:**

9.3.1 **Revise** “ten days” to read “fifteen (15) days”.

Add the following:

9.3.1.3 During progress of the Work, the Owner will pay Contractor ninety-five percent (95%) of the total amount of each monthly payment due. The remaining five percent (5%) will be retained by the Owner until the Project is substantially completed. There will be no further reduction considered until final acceptance of the Project in accordance with the Contract Documents.

9.3.2 **Add the following:** If the Contractor does not submit evidence of payment to vendor for material and equipment stored, the Architect will recommend deduction of the amount previously allowed for the items stored from the current or subsequent Application for Payment.

Add the following:

9.3.2.1 Contractor may include in Application for Payment the delivered cost of equipment and non-perishable materials delivered and stored at the site but not incorporated in the work, under the following conditions:

.1 Items to be protected from fire, theft, vandalism, weather, and other damage.
.2 Storage procedures and areas to be approved.
.3 Items to be available at all times for inspection by the Owner and Architect.

9.3.4 Contractor shall furnish with Application for Payment an invoice establishing value of material and equipment stored at the site along with a statement of amount to be paid the vendor.

.1 Such stored items are subject to inspection by Architect before payment is recommended.
.2 Contractor shall furnish Owner with Certificate of Insurance in accordance with Contract Documents for the full value of the items stored at the site.

9.6.2.1 Contractor shall furnish Architect with satisfactory evidence of payment to vendors supplying material and equipment for approved storage. This shall be done within thirty (30) days after the date of progress payment. Satisfactory evidence of payment shall be one (1) of the following:

.1 Contractor's canceled check in correct amount with identification of invoices paid.
.2 A letter or telegram from vendor with authorized signature stating amounts and invoices paid.
.3 A receipted invoice.

9.6.7.1 Payment for material and equipment delivered and stored shall not relieve Contractor of responsibility for furnishing equipment and material required for the work in the same manner as if such payment were not made.

9.10.6 A prerequisite to final payment shall be that the Contractor furnish proof that he has completed all specification requirements covering the following item as applicable:

Warranties.

ARTICLE 10 **Add the following:**

10.3.4.1 The Contractor shall not bring hazardous materials onto the site nor use in the Work without compliance with the following conditions.
.2 The Contractor shall be solely responsible for the handling, storage, and use of explosive or other hazardous materials when their use is permitted. For such use, the Contractor shall obtain necessary permits from regulating agencies and submit copies of permits to the Architect for review before proceeding with use.
.3 Contractor shall obtain insurance for use of hazardous material and furnish certificates of insurance in keeping with Conditions of the Contract.

ARTICLE 11 **Make the following changes and amend Article as indicated in the General Instructions to Bidders:**

11.1.1 **Revise** “authorized to do business in the jurisdiction in which the Project is located” to read “licensed to do business in Connecticut”.

11.1.2 **Revise** “authorized to do business in the jurisdiction in which the Project is located” to read “licensed to do business in Connecticut”.

11.2.2 **Revise** “prior to commencement of the Work” to read “within ten (10) days of Notice of Award”.

ARTICLE 15 **Make the following changes:**

15.3.2 **Revise to read as follows:** In addition to and prior to arbitration, the parties shall endeavor to settle disputes by mediation in accordance with the Construction Industry Mediation Rules of the American Arbitration Association currently in effect unless the parties mutually agree otherwise. Demand for mediation shall be filed in writing with the other party to this Agreement and with the American Arbitration Association. A demand for mediation shall be made within a reasonable time after the claim, dispute or other matter in w\question has arisen. In no event shall the demand for mediation be made after the date when institution of legal or equitable proceedings based on such claim, dispute or other matter in question would be barred by the applicable statute of limitations. The provisions of Article 15 notwithstanding, the Contractor expressly agrees to joinder in mediation proceedings between Owner/Architect upon specific written request of the Owner. This agreement shall be valid with the Architect's acceptance of an equal provision in their respective contracts.

END OF SECTION

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AIA® Document G702® – 1992

Application and Certificate for Payment

TO OWNER:		**PROJECT:**		**APPLICATION NO:** 001	**Distribution to:**
					OWNER:
				PERIOD TO:	ARCHITECT:
				CONTRACT FOR: General Construction	CONTRACTOR:
FROM		**VIA**		**CONTRACT DATE:**	FIELD:
CONTRACTOR:		**ARCHITECT:**		**PROJECT NOS:** / /	OTHER:

CONTRACTOR'S APPLICATION FOR PAYMENT

Application is made for payment, as shown below, in connection with the Contract.
AIA Document G703®, Continuation Sheet, is attached.

1. ORIGINAL CONTRACT SUM		$0.00
2. NET CHANGE BY CHANGE ORDERS		$0.00
3. CONTRACT SUM TO DATE (Line 1 ± 2)		$0.00
4. TOTAL COMPLETED & STORED TO DATE (Column G on G703)		$0.00
5. RETAINAGE:		
a. 0 % of Completed Work (Column D + E on G703: $0.00)	$0.00	
b. 0 % of Stored Material (Column F on G703: $0.00)	$0.00	
Total Retainage (Lines 5a + 5b or Total in Column I of G703)		$0.00
6. TOTAL EARNED LESS RETAINAGE (Line 4 Less Line 5 Total)		$0.00
7. LESS PREVIOUS CERTIFICATES FOR PAYMENT (Line 6 from prior Certificate)		$0.00
8. CURRENT PAYMENT DUE		$0.00
9. BALANCE TO FINISH, INCLUDING RETAINAGE (Line 3 less Line 6)	$0.00	

CHANGE ORDER SUMMARY	ADDITIONS	DEDUCTIONS
Total changes approved in previous months by Owner	$0.00	$0.00
Total approved this Month	$0.00	$0.00
TOTALS	$0.00	$0.00
NET CHANGES by Change Order		$0.00

The undersigned Contractor certifies that to the best of the Contractor's knowledge, information and belief the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, that all amounts have been paid by the Contractor for Work for which previous Certificates for Payment were issued and payments received from the Owner, and that current payment shown herein is now due.

CONTRACTOR:

By: _____ Date: _____

State of:
County of:
Subscribed and sworn to before me this day of
Notary Public:
My Commission expires:

ARCHITECT'S CERTIFICATE FOR PAYMENT

In accordance with the Contract Documents, based on on-site observations and the data comprising this application, the Architect certifies to the Owner that to the best of the Architect's knowledge, information and belief the Work has progressed as indicated, the quality of the Work is in accordance with the Contract Documents, and the Contractor is entitled to payment of the AMOUNT CERTIFIED.

AMOUNT CERTIFIED _____ $0.00

(Attach explanation if amount certified differs from the amount applied. Initial all figures on this Application and on the Continuation Sheet that are changed to conform with the amount certified.)

ARCHITECT:

By: _____ Date: _____

This Certificate is not negotiable. The AMOUNT CERTIFIED is payable only to the Contractor named herein. Issuance, payment and acceptance of payment are without prejudice to any rights of the Owner or Contractor under this Contract.

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AIA® Document G703® – 1992

Continuation Sheet

AIA Document G702®, Application and Certification for Payment, or G732™, Application and Certificate for Payment, Construction Manager as Adviser Edition, containing Contractor's signed certification is attached.
Use Column I on Contracts where variable retainage for line items may apply.

APPLICATION NO:
APPLICATION DATE:
PERIOD TO:
ARCHITECT'S PROJECT NO:

A	B	C	D	E	F	G		H	I
ITEM NO.	DESCRIPTION OF WORK	SCHEDULED VALUE	WORK COMPLETED FROM PREVIOUS APPLICATION (D + E)	WORK COMPLETED THIS PERIOD	MATERIALS PRESENTLY STORED (NOT IN D OR E)	TOTAL COMPLETED AND STORED TO DATE (D + E + F)	% (G ÷ C)	BALANCE TO FINISH (C - G)	RETAINAGE (IF VARIABLE RATE)
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
	GRAND TOTAL	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**0.00%**	**$0.00**	**$0.00**

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User Notes:

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Trumbull Public Schools Calendar 2023-2024

☐	No school
◯	No school for students; teacher work day
*	Early closing for students and staff
^	Early closing for grades PK-5
>	Early closing for grades PK-8
<	Early closing for grades 6-8
&	Early closing for grades 9-12

186 Teacher Days, 181 Student Days



JULY - 0 days

M	T	W	TH	F
3	4	5	6	7
10	11	12	13	14
17	18	19	20	21
24	25	26	27	28
31				

AUGUST - 3 days

M	T	W	TH	F
	1	2	3	4
7	8	9	10	11
14	15	16	17	18
21	◯22	◯23	◯24	◯25
◯28	29	30	31	

22, 23 New Staff Orientation
24,25,28 Teacher PD Days
29 First Day for Students (full day)

SEPTEMBER - 19 days

M	T	W	TH	F
				1
☐4	5	6	7	8
11	12	13	14	15
18	19	20	21	22
☐25	26	27	28	29

4 Labor Day
25 Yom Kippur

OCTOBER - 21 days

M	T	W	TH	F
2	3	4	5	6
☐9	10	11	12	13
16	17	18	19	20
23	24^	25	26>	27
30	31			

9 Columbus Day
24 Afternoon Conf. PK-5
26 Afternoon Conf. PK-8

NOVEMBER - 19 days

M	T	W	TH	F
		1	2^	3
6	◯7	8	9<	10
13	14&	15	16	17
20	21	22*	☐23	24
27	28	29	30	

2 Evening Conf. PK-5
7 Election Day, Teacher PD
9 Aft/Eve Conf. 6-8
14 Aft/Eve Conf. 9-12
23-24 Thanksgiving Recess

DECEMBER - 16 days

M	T	W	TH	F
				1
4	5	6	7	8
11	12	13	14	15
18	19	20	21	22*
☐25	26	27	28	29

25-29 Holiday Recess

JANUARY - 21 days

M	T	W	TH	F
☐1	2	3	4	5
8	9	10	11	12
☐15	16	17	18	19
22	23	24	25	26
29	30	31		

1 Final Day of Holiday Recess
15 Dr. Martin Luther King, Jr. Day

FEBRUARY - 19 days

M	T	W	TH	F
			1	2
5	6	7	8	9
12	13	14	15	☐16
☐19	20	21	22	23
26	27	28	29	

16 Long Weekend
19 Presidents' Day
16 Reserved as a "snow" make-up day

MARCH - 20 days

M	T	W	TH	F
				1
4	5	6	7&	8
11	12<	13	14^	15
18	19	20	21	22
25	26	27	28	☐29

7 Aft/Eve Conf. 9-12
12 Aft/Eve Conf. 6-8
14 Aft/Eve Conf. PK-5
29 Good Friday

APRIL - 16 days

M	T	W	TH	F
1	◯2	3	4	5
8	9	10	11	12
15	16	17	18	19
22	23	24	25	26
29	30			

2 Teacher PD Day
8-12 Vacation Week

MAY - 22 days

M	T	W	TH	F
		1	2	3
6	7	8	9	10
13	14	15	16	17
20	21	22	23	24
☐27	28	29	30	31

27 Memorial Day

JUNE - 5 days

M	T	W	TH	F
3	4	5	6	7
10	11	12	13	14
17	18	19	20	21
24	25	26	27	28

7 Planned last day of school
Last 2 days of school are early closing for students.
10-18 Reserved as "snow" make-up days

June 7 is the planned last day of school. Snow days, up to a maximum of 7, will be added to the end of the school year. If needed, an additional day will be taken from the February Long Weekend: February 16.

K-12 progress reporting periods, and report card dates, are maintained and updated on the TPS website: "Teaching & Learning," then "Assessment."

Approved by BOE: 11/16/2021
Revised & approved by BOE: 02/06/2024

Trumbull Public Schools Calendar 2024-2025

No school
No school for students; teacher work day
* Early closing for students and staff
^ Early closing for grades PK-5
> Early closing for grades PK-8
< Early closing for grades 6-8
& Early closing for grades 9-12

186 Teacher Days, 181 Student Days



JULY - 0 days

M	T	W	TH	F
1	2	3	**4**	5
8	9	10	11	12
15	16	17	18	19
22	23	24	25	26
29	30	31		

AUGUST - 4 days

M	T	W	TH	F
			1	2
5	6	7	8	9
12	13	14	15	16
19	20	21	22	23
26	27	28	29	30

20-21 New Staff Orientation
22-23, 26 Teacher PD Days
27 First Day for Students (full day)

SEPTEMBER - 20 days

M	T	W	TH	F
2	3	4	5	6
9	10	11	12	13
16	17	18	19	20
23	24	25	26	27
30				

2 Labor Day

OCTOBER - 20 days

M	T	W	TH	F
	1	2	**3**	4
7	8	9	10	11
14	15	16	17	18
21	22^	23	24>	25
28	29	30	31	

3 Rosh Hashanah
14 Columbus/Indigenous Peoples
22 Afternoon Conf. PK-5
24 Afternoon Conf. PK-8
31 Diwali

NOVEMBER - 18 days

M	T	W	TH	F
				1
4	5	6	7^	8
11	12	13	14<	15
18	19	20	21&	22
25	26	27*	**28**	**29**

5 Election Day, Teacher PD
7 Evening Conf. PK-5
14 Aft/Eve Conf. 6-8
21 Aft/Eve Conf. 9-12
28-29 Thanksgiving Recess

DECEMBER - 15 days

M	T	W	TH	F
2	3	4	5	6
9	10	11	12	13
16	17	18	19	20*
23	24	**25**	26	27
30	31			

23-27, 30-31 Winter Recess
25 Christmas Day

JANUARY - 21 days

M	T	W	TH	F
		1	2	3
6	7	8	9	10
13	14	15	16	17
20	21	22	23	24
27	28	29	30	31

1 Final Day of Holiday Recess/ New Year's Day
20 Dr. Martin Luther King, Jr. Day

FEBRUARY - 18 days

M	T	W	TH	F
3	4	5	6	7
10	11	12	13	**14**
17	18	19	20	21
24	25	26	27	28

14 Long Weekend
17 Presidents' Day/ Washington's Birthday
14 Reserved as a "snow" make-up day

MARCH - 20 days

M	T	W	TH	F
3	4	5	6&	7
10	11<	12	13^	14
17	18	19	20	21
24	25	26	27	28
31				

6 Aft/Eve Conf. 9-12
11 Aft/Eve Conf. 6-8
13 Aft/Eve Conf. PK-5
17 Teacher PD Day

APRIL - 17 days

M	T	W	TH	F
	1	2	3	4
7	8	9	10	11
14	15	16	17	**18**
21	22	23	24	25
28	29	30		

14-18 Vacation Week
18 Good Friday

MAY - 21 days

M	T	W	TH	F
			1	2
5	6	7	8	9
12	13	14	15	16
19	20	21	22	23
26	27	28	29	30

26 Memorial Day

JUNE - 7 days

M	T	W	TH	F
2	3	4	5	6
9	10	11	12	13
16	17	18	19	20
23	24	25	26	27

10 Planned last day of school
19 Juneteenth
Last 2 days of school are early closing for students.
11-20 Reserved as "snow" make-up days

June 10 is the planned last day of school. Snow days, up to a maximum of 7, will be added to the end of the school year. If needed, an additional day will be taken from the February Long Weekend: February 14. If an 8th day is needed, or if an additional day is needed after the February Long Weekend, that day will be recovered on the March PD Day, which will be a legal day. Teachers will then attend one more day in June.

K-12 progress reporting periods, and report card dates, are maintained and updated on the TPS website: "Teaching & Learning," then "Assessment."

BOE Approved: 07/11/2023
Revised & approved by BOE: 02/06/2024

Trumbull Public Schools Calendar 2025-2026

No school
No school for students; teacher work day
* Early closing for students and staff
^ Early closing for grades PK-5
> Early closing for grades PK-8
< Early closing for grades 6-8
& Early closing for grades 9-12

185 Teacher Days, 181 Student Days

JULY - 0 days

M	T	W	TH	F
	1	2	3	4
7	8	9	10	11
14	15	16	17	18
21	22	23	24	25
28	29	30	31	

AUGUST - 4 days

M	T	W	TH	F
				1
4	5	6	7	8
11	12	13	14	15
18	19	20	21	22
25	26	27	28	29

19, 20 New Staff Orientation
21,22,25 Teacher PD Days
26 First Day for Students (full day)

SEPTEMBER - 20 days

M	T	W	TH	F
1	2	3	4	5
8	9	10	11	12
15	16	17	18	19
22	23	24	25	26
29	30			

1 Labor Day
23 Rosh Hashana

OCTOBER - 20 days

M	T	W	TH	F
		1	2	3
6	7	8	9	10
13	14	15	16	17
20	21	22	23>	24
27	28^	29	30	31

2 Yom Kippur
13 Columbus/Indigenous Peoples
20 Diwali
23 Afternoon Conf. PK-8
28 Afternoon Conf. PK-5

NOVEMBER - 17 days

M	T	W	TH	F
3	4	5	6^	7
10	11	12	13<	14
17	18	19	20&	21
24	25	26*	27	28

4 Election Day, Teacher PD
6 Evening Conf. PK-5
13 Aft/Eve Conf. 6-8
20 Aft/Eve Conf. 9-12
27-28 Thanksgiving Recess

DECEMBER - 17 days

M	T	W	TH	F
1	2	3	4	5
8	9	10	11	12
15	16	17	18	19
22	23*	24	25	26
29	30	31		

24-26, 29-31 Winter Recess
25 Christmas Day

JANUARY - 20 days

M	T	W	TH	F
			1	2
5	6	7	8	9
12	13	14	15	16
19	20	21	22	23
26	27	28	29	30

1 Final Day of Holiday Recess/ New Year's Day
19 Dr. Martin Luther King, Jr. Day

FEBRUARY - 18 days

M	T	W	TH	F
2	3	4	5	6
9	10	11	12	13
16	17	18	19	20
23	24	25	26	27

13 Long Weekend
16 Presidents' Day
Washington's Birthday
13 Reserved as a "snow" make-up day

MARCH - 20 days

M	T	W	TH	F
2	3	4	5&	6
9	10<	11	12^	13
16	17	18	19	20
23	24	25	26	27
30	31			

5 Aft/Eve Conf. 9-12
10 Aft/Eve Conf. 6-8
12 Aft/Eve Conf. PK-5
19 Teacher PD
20 Eid al-Fitr

APRIL - 16 days

M	T	W	TH	F
		1	2	3
6	7	8	9	10
13	14	15	16	17
20	21	22	23	24
27	28	29	30	

3 Good Friday
13-17 Vacation Week

MAY - 20 days

M	T	W	TH	F
				1
4	5	6	7	8
11	12	13	14	15
18	19	20	21	22
25	26	27	28	29

25 Memorial Day

JUNE - 9 days

M	T	W	TH	F
1	2	3	4	5
8	9	10	11	12
15	16	17	18	19
22	23	24	25	26
29	30			

11 Planned last day of school
19 Juneteenth
Last 2 days of school are early closing for students.
12-23 Reserved as "snow" make-up days

June 11 is the planned last day of school. Snow days, up to a maximum of 7, will be added to the end of the school year. If needed, an additional day will be taken from the February Long Weekend: February 13. If an 8th day is needed, or if an additional day is needed after the February Long Weekend, that day will be recovered on the March PD Day, which will be a legal day. Teachers will then attend one more day in June.

K-12 progress reporting periods, and report card dates, are maintained and updated on the TPS website: "Teaching & Learning," then "Assessment."

BOE Approved: 7/11/2023

FACILITIES HVAC UPGRADE

MIDDLEBROOK ELEMENTARY SCHOOL
220 MIDDLEBROOK AVENUE
TRUMBULL, CT 06611
STATE PROJECT #144-____
BID #__/__-__

S/P+A PROJECT NO. 22.335

Drawing Number	Drawing Name
	COVER SHEET
INFORMATION & CODE DRAWINGS	
G100	GENERAL & CODE INFORMATION
CIVIL DRAWINGS	
C100	PARTIAL SITE PLAN
ARCHITECTURAL DRAWINGS	
A001	BUILDING 'B' DEMOLITION PLANS
A002-A099	NOT USED
A100	BUILDING 'B' FLOOR PLANS & DETAILS
A101-A199	NOT USED
A200	BUILDING 'B' REFLECTED CEILING PLANS
FIRE PROTECTION DRAWINGS	
FP001	GENERAL NOTES
F002-F109	NOT USED
F110	BUILDING 'B' FIRST & SECOND PARTIAL FLOOR PLANS
F111-F200	NOT USED
FP201	SCHEDULES & DETAILS
PLUMBING DRAWINGS	
P001	GENERAL NOTES
P002-P109	NOT USED
P110	BASEMENT/GROUND FLOOR PLAN
P111	BUILDING 'B' FIRST & SECOND FLOOR PARTIAL FLOOR PLANS
P112	ROOF PLAN
P113-P200	NOT USED
P201	SCHEDULES & DETAILS
MECHANICAL DRAWINGS	
M001	MECHANICAL NOTES, LEGENDS & ABBREVIATIONS
M002-M009	NOT USED
M010	BUILDING 'B FIRST & SECOND FLOOR DEMOLITION PLANS – MECHANICAL
M011	BUILDING 'B' ROOF DEMOLITION PLAN – MECHANICAL
M012-M109	NOT USED
M110	BUILDING 'B' FIRST & SECOND FLOOR PLANS – MECHANICAL
M111	BUILDING 'B' ROOF PLAN – MECHANICAL
M112-M200	NOT USED
M201-M202	BUILDING 'B' MECHANICAL DETAILS

M203-M300	NOT USED
M301-M303	BUILDING 'B' MECHANICAL SCHEDULES
M304-M400	NOT USED
M401-M402	BUILDING 'B' MECHANICAL VRF SYSTEM DIAGRAMS

ELECTRICAL DRAWINGS

E001	SYMBOLS, NOTES & ABBREVIATIONS
E002-E009	NOT USED
E010	BUILDING 'B' FIRST & SECOND FLOOR DEMOLITION PLANS
E011	BUILDING 'B' ROOF & BASEMENT FLOOR DEMOLITION PLANS
E012-E109	NOT USED
E110	BUILDING 'B' FIRST & SECOND FLOOR POWER PLANS
E111	BUILDING 'B' ROOF & BASEMENT FLOOR POWER PLANS
E112-E209	NOT USED
E210	BUILDING 'B' FIRST & SECOND FLOOR LIGHTING PLANS
E210A	BUILDING 'B' FIRST & SECOND FLOOR 'ALTERNATE' LIGHTING PLANS
E211-E300	NOT USED
E301	PARTIAL SITE PLAN
E302-E400	NOT USED
E401	ONE-LINE RISER DIAGRAM
E402-E500	NOT USED
E501	LIGHT FIXTURE & PANEL BOARD SCHEDULES
E502-E600	NOT USED
E601-E602	DETAILS

END OF SECTION

SECTION 011000 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 PROJECT DESCRIPTION

A. The Work of the Project is defined by the Contract Documents and consists of HVAC upgrades to an existing building.

B. The Work generally includes, but is not necessarily limited to the following major elements:

1. Removal of selected building materials and components, including selected existing plumbing, mechanical, and electrical systems.
2. Offsite disposal of all removed materials.
3. Provision and installation of new retaining wall, railing, and bollards.
4. Demolition of existing floor slab assembly where indicated.
5. Provision and installation of new steel lintels, cmu shaft enclosures, gypsum board and metal stud infill and soffit, countertop, firestopping, and sealants.
6. Removal of existing concrete stairs and replacement with new metal grate stairs.
7. Removal and replacement of existing ceiling tile and grid.
8. Cutting and patching to match existing, including painting and resilient base.
9. Relocation of existing exposed sprinkler piping and side wall heads to accommodate new duct riser/shafts on the first and second floors.
10. Provision and installation of gas to new rooftop equipment sized for future loads. Modification and reconnection of gas to existing distribution system following reconfiguration of existing gas meter assembly by the gas company.
11. Provision and installation of condensate drainage discharging to grade in support of new VRF units located on the second floor.
12. Mechanical:

    a. Removal of existing roof mounted ventilation exhaust fans, associated ductwork, and controls serving Level 1 and 2 classrooms and corridors.
    b. Removal of existing ceiling mounted unit heaters, associated ductwork, controls, and roof mounted gooseneck serving both Level 1 and 2 workrooms.
    c. Removal of existing split systems (wall mounted air-conditioning units, associated outdoor condensing units, controls, and refrigerant piping) from several classrooms.
    d. Abandonment of existing classroom unit ventilators and associated louvers, including their sealing and insulating.
    e. Removal and replacement of existing inline exhaust fans, associated ductwork, controls, and exterior louvers serving Level 1 single toilet room and Level 2 custodial closet.
    f. Provision and installation of new dedicated outside-air system to provide ventilation to all classrooms, offices, and workrooms located on Level 1 and 2 of Building B.
    g. Provision and installation of new VRF systems to provide cooling and heating to existing classrooms and offices located on Level 1 and 2 of Building B.

13. Electrical:

    a. Removal and replacement of existing service with new switch and current transformer to support new mechanical system.
    b. Provision and installation of new distribution panels, panelboards, and transformer.
    c. Removal and replacement of existing corridor light fixtures.

1.3 CONTRACTOR USE OF PREMISES

A. General: Limit use of the premises to construction activities in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

B. Confine operations to as small work areas and accessways as possible. As much as possible and without damage to the finishes, doors, and related building systems, access the project area via the service doors designated by Owner.

C. Keep driveways and entrances serving the premises clear and available to the Owner and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.

D. Maintain existing egress patterns, exit doors, and means of egress during construction, which will include the provision of temporary walkways, sidewalks, or other means necessary to provide adequate life safety for the building occupants, particularly at exitways which must continue to be open and serviceable while adjacent construction activity occurs.

E. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

    1. Contractor is responsible to secure project area/site from intrusions during unoccupied (after hours) period of time. Any temporary doors and /or window coverings that may be necessary to complete repairs are the Contractors responsibility to furnish and install as part of the project scope.

1.4 OWNER OCCUPANCY

A. Full Owner Occupancy: The Owner's administrative and maintenance staff as well as building tenants will occupy the site and existing buildings during the entire construction period, with children on site during the school year. Cooperate with the Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with the Owner's operations. Pre-schedule construction operations with the Owner for areas that must be evacuated for extended periods, giving the Owner the opportunity to relocate administrative or educational operations to non-affected areas.

    1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
    2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

1.5 SPECIAL REQUIREMENTS

A. The Contractor shall ensure that all work performed is done so in a safe manner and that all his/her employees shall adhere to all applicable safety procedures and practices at all times.

There may be children and staff in the vicinity of the work area during normal working hours. The Contractor shall be aware at all times that additional safety considerations should be taken. Particular care shall be taken by the Contractor, Subcontractors and all those in their employ, that all tools, equipment, ladders, etc. are never left unsupervised.

B. Meaningful Instruction: Meaningful instruction (as determined by the Owner) must be facilitated and possible within the building at all times. This requirement may limit the Contractor's demolition and construction operations as the distraction represented by hammering, material movement, etc. may disrupt classes. No down time or mobilization charges will be permitted should the meaningful instruction requirement suspend the Contractor's operations for any length of time.

C. Testing: During the school year, Smarter Balanced Assessment Consortium may be administered to portions of the student population, which requires absolute concentration on the part of the students. The Owner may prohibit operations during the administration of these assessments. Cooperate with the Owner to determine the schedule, locations of the testing and where operations may proceed with disrupting classroom or roofing operations.

D. Under no circumstances shall the buildings' occupants be subjected to excessive construction noise or vibrations, nor shall they be subject to fumes, odors, or other deleterious effects of the operation. Should material delivery, demolition or construction operations, inclement weather, or related schedule conditions produce this situation (as determined by the Owner), the Contractor shall be required to suspend operations that produce the offending effects until such time as the building is not occupied, or as approved by the Owner.

E. Schedule:

1. Work (meaning shop drawings and procurement) for the project can begin immediately after the contract signing. However, the on-site construction period cannot begin until school has been dismissed for the Summer. Owner will provide Contractor a 30-day advanced notice of the exact start date based on the School Calendar and potential snow days.

F. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances inside the building or on the grounds is not permitted. Strict adherence to the regulations will be enforced for the entire duration of the construction.

G. There will be absolutely **no** fraternizing with the students by construction personnel. Anyone caught doing so will be required to leave the jobsite and will not be permitted to return. Such dismissal shall not give the contractor grounds for default on any other contract requirements, including the construction schedule.

H. Site Security – Identification Badges

1. The Contractor shall provide a list of all contact persons. The list shall include each trade, name of Contractor, contact person(s), phone numbers, fax numbers, Federal Employer Identification Number (FEIN), social security number if FEIN is not available, and Connecticut Tax Registration number.
2. Prior to the start of work all Contractor and Sub-Contactor personnel assigned to perform work shall be required to fill out and submit to a background check at a cost provided by the Contractor. All information shall be submitted to the Town of Trumbull. Information for background check includes the following:

    a. Identity Verification
    b. Criminal Background

c. Additional checks as deemed warranted.

3. Security badges will be worn by all project personnel during construction activities. The Contractor will provide badges at no cost to the Owner. The Contractor will be responsible for monitoring the display of badges, including those of the personnel of all subcontractors and visitors to the project site.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract. No extensions of time shall be granted for accepted alternates.

D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. **DEDUCT ALTERNATE #1: Lighting Replacement:** Deduct from the Base Bid the removal and replacement of corridor lighting and instead include the removal and reinstallation of the existing lighting as indicated in Drawing E210A.

END OF SECTION 012300

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Sections:

1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
2. Divisions 02 through 49 Sections for specific requirements and limitations for substitutions.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 SUBMITTALS

A. Substitution Requests: Submit three (3) copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use **CSI Form 1.5C**, **13.1A**, or comparable form.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
c. Detailed, SIDE-BY-SIDE comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable specification section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects with project names and addresses and names and addresses of Architects and Owners.
h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven (7) days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within fifteen (15) days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Modify or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Procurement Substitution Request: Submit to Architect seven (7) days prior to date of bid opening.

B. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not later than fifteen (15) days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
b. Substitution request is fully documented and properly submitted.
c. Requested substitution will not adversely affect Contractor's construction schedule.
d. Requested substitution has received necessary approvals of authorities having jurisdiction.
e. Requested substitution is compatible with other portions of the Work.
f. Requested substitution has been coordinated with other portions of the Work.
g. Requested substitution provides specified warranty.
h. If requested substitution involves more than one (1) contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

C. Substitutions for Convenience: Architect will consider requests for substitution if received within sixty (60) days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
b. Requested substitution does not require extensive revisions to the Contract Documents.
c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
d. Substitution request is fully documented and properly submitted.
e. Requested substitution will not adversely affect Contractor's construction schedule.
f. Requested substitution has received necessary approvals of authorities having jurisdiction.
g. Requested substitution is compatible with other portions of the Work.
h. Requested substitution has been coordinated with other portions of the Work.
i. Requested substitution provides specified warranty.
j. If requested substitution involves more than one (1) contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Sections:

1. Section 016000 "Product Requirements" for administrative procedures for handling requests for substitutions made after Contract award.

1.3 MINOR CHANGES IN THE WORK

A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions."

1.4 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
2. Within time specified in Proposal Request or twenty (20) days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

    a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    c. Include costs of labor and supervision directly attributable to the change.
    d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
    e. Quotation Form: Use forms acceptable to Architect.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to the Architect.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form acceptable to Architect.

1.5 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

1.6 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Sections:

1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
2. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.
3. Section 013300 "Submittal Procedures" for administrative requirements governing the preparation and submittal of the submittal schedule.

1.3 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

1. Correlate line items in the schedule of values with other required administrative forms and schedules, including the following:

   a. Application for Payment forms with continuation sheets.
   b. Submittal schedule.
   c. Items required to be indicated as separate activities in Contractor's construction schedule.

2. Submit the schedule of values to Architect at earliest possible date but no later than seven (7) days before the date scheduled for submittal of initial Applications for Payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one (1) line item for each Specification Section.

1. Identification: Include the following Project identification on the schedule of values:

   a. Project name and location.
   b. Name of Architect.
   c. Architect's project number.
   d. Contractor's name and address.
   e. Date of submittal.

2. Arrange schedule of values consistent with format of AIA Document G703.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project

Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent (5%) of Contract Sum.

4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

    a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.

6. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.

8. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.4 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.

    1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.

    1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
    2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
    3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
    4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
    5. Include updated and approved Contractor’s construction schedule, potential Change Order Log and Product Submittal Log.

E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Materials previously stored and included in previous Applications for Payment.
    b. Work completed for this Application utilizing previously stored materials.
    c. Additional materials stored with this Application.
    d. Total materials remaining stored, including materials with this Application.

F. Transmittal: Submit three (3) signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One (1) copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
5. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.

H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of values.
3. Contractor's construction schedule (preliminary if not final).
4. Products list (preliminary if not final).
5. Submittal schedule (preliminary if not final).
6. List of Contractor's staff assignments.
7. List of Contractor's principal consultants.
8. Copies of building permits.
9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
10. Initial progress report.
11. Report of preconstruction conference.
12. Certificates of insurance and insurance policies.
13. Performance and payment bonds.
14. Data needed to acquire Owner's insurance.

I. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing one hundred percent (100%) completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

J. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General project coordination procedures.
2. Administrative and supervisory personnel.
3. Requests for Information (RFIs).
4. Project meetings.

B. Related Sections:

1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
2. Section 017300 "Execution" for procedures for coordinating general installation.
3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

A. RFI: Request from Owner, Architect, or Contractor seeking information from each other during construction.

1.4 COORDINATION

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one (1) part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate Contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Pre-installation conferences.
7. Startup and adjustment of systems.
8. Project closeout activities.

D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.5 KEY PERSONNEL

A. Key Personnel Names: Within fifteen (15) days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and email addresses. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.6 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.

10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716 or comparable form.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven (7) working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.

1. The following RFIs will be returned without action:

    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for coordination information already indicated in the Contract Documents.
    d. Requests for adjustments in the Contract Time or the Contract Sum.
    e. Requests for interpretation of Architect's actions on submittals.
    f. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

    a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within ten (10) days of receipt of the RFI response.

E. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven (7) days if Contractor disagrees with response.

F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Architect.
4. RFI number including RFIs that were dropped and not submitted.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.
8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

1.7 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: General Contractor or Construction Manager is responsible for recording significant discussions and agreements achieved. General Contractor or Construction Manager is also responsible for distributing the meeting minutes to everyone concerned including Owner and Architect, within three (3) days of the meeting.

B. Preconstruction/Preinstallation Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than fifteen (15) days after execution of the Agreement.

1. Conduct the conference to review responsibilities and personnel assignments.
2. Attendees: Authorized representatives of Owner, Construction Administrator, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect progress, including the following:

a. Tentative construction schedule.
b. Phasing.
c. Critical work sequencing and long-lead items.
d. Designation of key personnel and their duties.
e. Lines of communications.
f. Procedures for processing field decisions and Change Orders.
g. Procedures for RFIs.
h. Procedures for testing and inspecting.
i. Procedures for processing Applications for Payment.
j. Distribution of the Contract Documents.
k. Submittal procedures.
l. Preparation of record documents.
m. Work restrictions.
n. Working hours.
o. Owner's occupancy requirements.
p. Responsibility for temporary facilities and controls.
q. Procedures for moisture and mold control.
r. Procedures for disruptions and shutdowns.
s. Parking availability.
t. Office, work, and storage areas.
u. Equipment deliveries and priorities.
v. First aid.
w. Security.
x. Progress cleaning.

4. Minutes: General Contractor or Construction Manager is responsible for recording and distributing meeting minutes.

C. Project Closeout Conference: Schedule and conduct a Project closeout conference, at a time convenient to Owner and Architect, but no later than thirty (30) days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

    a. Preparation of record documents.
    b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
    c. Submittal of written warranties.
    d. Requirements for preparing operations and maintenance data.
    e. Requirements for demonstration and training.
    f. Preparation of Contractor's punch list.
    g. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
    h. Submittal procedures.
    i. Responsibility for removing temporary facilities and controls.

4. Minutes: General Contractor or Construction Manager is responsible for recording and distributing meeting minutes.

D. Progress Meetings: Conduct progress meetings at biweekly intervals.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner and Architect, each Contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

        1) Review schedule for next period.

    b. Review present and future needs of each entity present, including the following:

        1) Interface requirements.
        2) Sequence of operations.
        3) Status of submittals.
        4) Deliveries.
        5) Off-site fabrication.
        6) Access.
        7) Site utilization.
        8) Temporary facilities and controls.
        9) Progress cleaning.

10) Quality and work standards.
11) Status of correction of deficient items.
12) Field observations.
13) Status of RFIs.
14) Status of proposal requests.
15) Pending changes.
16) Status of Change Orders.
17) Pending claims and disputes.
18) Documentation of information for payment requests.

4. Minutes: General Contractor or Construction Manager is responsible for recording and distributing meeting minutes.

   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor's construction schedule.
2. Daily construction reports.
3. Material location reports.
4. Field condition reports.
5. Special reports.

B. Related Sections:

1. Section 013300 "Submittal Procedures" for submitting schedules and reports.
2. Section 014000 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by Architect.

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Event: The starting or ending point of an activity.

E. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.

3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

F. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. PDF electronic file.

B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

C. Daily Construction Reports: Submit at weekly intervals.

D. Material Location Reports: Submit at weekly intervals.

E. Field Condition Reports: Submit at time of discovery of differing conditions.

F. Special Reports: Submit at time of unusual event.

1.5 QUALITY ASSURANCE

A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the Contractor's construction schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Discuss constraints, including phasing, work stages and area separations.
3. Review time required for review of submittals and resubmittals.
4. Review requirements for tests and inspections by independent testing and inspecting agencies.
5. Review time required for completion and startup procedures.
6. Review and finalize list of construction activities to be included in schedule.
7. Review submittal requirements and procedures.
8. Review procedures for updating schedule.

1.6 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.

2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than twenty (20) days, unless specifically allowed by Architect.
2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than sixty (60) days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
4. Startup and Testing Time: Include not less than fifteen (15) days for startup and testing.
5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
6. Punch List and Final Completion: Include not more than thirty (30) days for punch list and final completion.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work Restrictions: Show the effect of the following items on the schedule:

a. Coordination with existing construction.
b. Uninterruptible services.
c. Use of premises restrictions.
d. Provisions for future construction.
e. Seasonal variations.
f. Environmental control.

3. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

a. Subcontract awards.
b. Submittals.
c. Purchases.
d. Fabrication.
e. Sample testing.
f. Deliveries.

g. Installation.
h. Tests and inspections.
i. Adjusting.
j. Startup and placement into final use and operation.

4. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:

a. Completion of mechanical installation.
b. Completion of electrical installation.
c. Substantial Completion.

D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion**.**

E. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.

1. Refer to Section 012900 "Payment Procedures" for cost reporting and payment procedures.

F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered RFIs.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.

G. Recovery Schedule: When periodic update indicates the Work is fourteen (14) or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

H. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal Gantt-chart-type, Contractor's construction schedule within seven (7) days of date established for the Notice to Proceed.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in ten percent (10%) increments within time bar.

2.3 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (refer to special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

B. Material Location Reports: At weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.

C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.4 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one (1) day of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one (1) week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect, Construction Administrator, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Periodic construction photographs.

B. Related Sections:

1. Section 013300 "Submittal Procedures" for submitting photographic documentation.
2. Section 017700 "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.

1.3 FORMATS AND MEDIA

A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels. Use flash in low light levels or backlit conditions.

B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

C. Metadata: Record accurate date and time from camera.

D. File Names: Name media files with date, Project area, and sequential numbering suffix.

1.4 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs using the maximum depth of field and in focus. Photographs with blurry or out-of-focus areas will not be accepted.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.
2. Field Office Images: Maintain one (1) set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.

B. Periodic Construction Photographs: Take eighteen to twenty (18-20) photographs weekly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

C. Additional Photographs: Architect may request photographs in addition to periodic photographs specified.

1. In emergency situations, take additional photographs within 24 hours of request.

2. Circumstances that could require additional photographs include, but are not limited to, the following:

    a. Immediate follow-up when on-site events result in construction damage or losses.
    b. Substantial Completion of a major phase or component of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013233

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Sections:

1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
3. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
4. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as action submittals.

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as informational submittals.

C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or modifications to submittals noted by the Architect and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Submit concurrently with Contractor's construction schedule. Include submittals required during the first sixty (60) days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal Category: Action, informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Architect's final release or approval.
    g. Scheduled dates for purchasing.
    h. Scheduled dates for installation.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect's Digital Data Files: Electronic copies of the CAD Drawings of the Contract Drawings will **not** be provided by Architect for Vendor's use in preparing submittals unless requested and Architect's user agreement properly completed.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow ten (10) days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Resubmittal Review: Allow ten (10) days for review of each resubmittal.
3. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow fifteen (15) days for initial review of each submittal.

D. Identification and Information: Place a permanent label or title block on each paper copy submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
3. Include the following information for processing and recording action taken:

    a. Project name.
    b. Date.
    c. Name of Architect.
    d. Name of Contractor.
    e. Name of subcontractor.
    f. Name of supplier.
    g. Name of manufacturer.
    h. Submittal number or other unique identifier, including revision identifier.

        1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

    i. Number and title of appropriate Specification Section.
    j. Drawing number and detail references, as appropriate.
    k. Location(s) where product is to be installed, as appropriate.
    l. Other necessary identification.

E. Identification and Information: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

    a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
4. Include the following information on an inserted cover sheet:

    a. Project name.
    b. Date.
    c. Name and address of Architect.
    d. Name of Contractor.
    e. Name of firm or entity that prepared submittal.
    f. Name of subcontractor.
    g. Name of supplier.
    h. Name of manufacturer.
    i. Number and title of appropriate Specification Section.
    j. Drawing number and detail references, as appropriate.
    k. Location(s) where product is to be installed, as appropriate.
    l. Related physical samples submitted directly.
    m. Other necessary identification.

5. Include the following information as keywords in the electronic file metadata:

a. Project name.
b. Number and title of appropriate Specification Section.
c. Manufacturer name.
d. Product name.

F. Options: Identify options requiring selection by the Architect.

G. Deviations: Identify deviations from the Contract Documents on submittals.

H. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

I. Transmittal: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review received from sources other than Contractor.

1. Transmittal Form: Provide locations on form for the following information:

a. Project name.
b. Date.
c. Destination (To:).
d. Source (From:).
e. Names of subcontractor, manufacturer, and supplier.
f. Category and type of submittal.
g. Submittal purpose and description.
h. Specification Section number and title.
i. Indication of full or partial submittal.
j. Drawing number and detail references, as appropriate.
k. Transmittal number**,** numbered consecutively.
l. Submittal and transmittal distribution record.
m. Remarks.
n. Signature of transmitter.

2. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

J. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

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

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

L. Use for Construction: Use only final submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Submit electronic submittals via email as PDF electronic files.

a. Architect will return annotated file. Annotate and retain one (1) copy of file as an electronic Project record document file.

2. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."
3. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

4. Test and Inspection Reports Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data is not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8½ by 11 inches but no larger than 30 by 42 inches.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one (1) submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

a. Generic description of Sample.
b. Product name and name of manufacturer.
c. Sample source.
d. Number and title of applicable Specification Section.

3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents.
2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.

F. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."

G. Application for Payment: Comply with requirements specified in Section 012900 "Payment Procedures."

H. Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures."

I. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design**.** Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

J. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Architects and Owners, and other information specified.

K. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on American Welding Society (AWS) forms. Include names of firms and personnel certified.

L. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

M. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

N. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

O. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

P. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

Q. Product Test Reports: Submit written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

R. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

S. Schedule of Tests and Inspections: Comply with requirements specified in Section 014000 "Quality Requirements."

T. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

U. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

V. Field Test Reports: Submit reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

W. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Section 017700 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

E. Incomplete submittals are not acceptable, will be considered nonresponsive, and will be returned without review.

F. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections:

1. Divisions 02 through 49 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor’s quality-control services do not include contract enforcement activities performed by Architect.

C. Preconstruction Testing: Tests and inspections performed specifically for the Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

D. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

E. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.

F. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

H. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade or trades.

I. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five (5) previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.5 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two (2) or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 ACTION SUBMITTALS

A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems.

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified.

G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within ten (10) days of Notice to Proceed, and not less than five (5) days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: Include in quality-control plan a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
3. Owner-performed tests and inspections indicated in the Contract Documents.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

1.11 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
3. Costs for testing that is cancelled will be charged to the Contractor, and the Contract Sum will be adjusted by Change Order.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect, Contractor and to authorities having jurisdiction.

4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
11. AF&PA - American Forest & Paper Association; www.afandpa.org.
12. AGA - American Gas Association; www.aga.org.
13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
15. AI - Asphalt Institute; www.asphaltinstitute.org.
16. AIA - American Institute of Architects (The); www.aia.org.
17. AISC - American Institute of Steel Construction; www.aisc.org.
18. AISI - American Iron and Steel Institute; www.steel.org.
19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
21. ANSI - American National Standards Institute; www.ansi.org.
22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
23. APA - APA - The Engineered Wood Association; www.apawood.org.
24. APA - Architectural Precast Association; www.archprecast.org.
25. API - American Petroleum Institute; www.api.org.
26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASCE - American Society of Civil Engineers; www.asce.org.
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
34. ASSP - American Society of Safety Professionals (The); www.assp.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AVIXA - Audiovisual and Integrated Experience Association; (Formerly: Infocomm International); www.soundandcommunications.com.

38. AWEA - American Wind Energy Association; www.awea.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
41. AWPA - American Wood Protection Association; www.awpa.com.
42. AWS - American Welding Society; www.aws.org.
43. AWWA - American Water Works Association; www.awwa.org.
44. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
45. BIA - Brick Industry Association (The); www.gobrick.com.
46. BICSI - BICSI, Inc.; www.bicsi.org.
47. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
48. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
49. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
50. CDA - Copper Development Association; www.copper.org.
51. CE - Conformite Europeenne; www.ec.europa.eu/growth/single-market/ce-marking.
52. CEA - Canadian Electricity Association; www.electricity.ca.
53. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CGA - Compressed Gas Association; www.cganet.com.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
57. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
58. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CPA - Composite Panel Association; www.compositepanel.org.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRRC - Cool Roof Rating Council; www.coolroofs.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
64. CSA - CSA Group; www.csa-group.org.
65. CSI - Construction Specifications Institute (The); www.csiresources.org.
66. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
67. CTA - Consumer Technology Association; www.cta.tech.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.coolingtechnology.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHA - Decorative Hardwoods Association; (Formerly: Hardwood Plywood & Veneer Association); www.decorativehardwoods.org.
72. DHI - Door and Hardware Institute; www.dhi.org.
73. ECA - Electronic Components Association; (See ECIA).
74. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
75. ECIA - Electronic Components Industry Association; www.ecianow.org.
76. EIA - Electronic Industries Alliance; (See TIA).
77. EIMA - EIFS Industry Members Association; www.eima.com.
78. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
79. EOS/ESD Association; (Electrostatic Discharge Association); www.esda.org.
80. ESTA - Entertainment Services and Technology Association; (See PLASA).
81. ETL - Intertek (See Intertek); www.intertek.com.
82. EVO - Efficiency Valuation Organization; www.evo-world.org.
83. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
84. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
85. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
86. FM Approvals - FM Approvals LLC; www.fmglobal.com.

87. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
88. FRSA - Florida Roofing, Sheet Metal Contractors Association, Inc.; www.floridaroof.com.
89. FSA - Fluid Sealing Association; www.fluidsealing.com.
90. FSC - Forest Stewardship Council U.S.; www.fscus.org.
91. GA - Gypsum Association; www.gypsum.org.
92. GANA - Glass Association of North America; (See NGA).
93. GS - Green Seal; www.greenseal.org.
94. HI - Hydraulic Institute; www.pumps.org.
95. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
96. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
97. HPVA - Hardwood Plywood & Veneer Association; (See DHA).
98. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
99. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
100. IAS - International Accreditation Service; www.iasonline.org.
101. ICBO - International Conference of Building Officials; (See ICC).
102. ICC - International Code Council; www.iccsafe.org.
103. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
104. ICPA - International Cast Polymer Association; www.theicpa.com.
105. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
106. IEC - International Electrotechnical Commission; www.iec.ch.
107. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
108. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
109. IESNA - Illuminating Engineering Society of North America; (See IES).
110. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
111. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
112. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
113. II - Infocomm International; (See AVIXA).
114. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
115. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
116. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
117. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
118. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
119. ISO - International Organization for Standardization; www.iso.org.
120. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
121. ITU - International Telecommunication Union; www.itu.int.
122. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
123. LMA - Laminating Materials Association; (See CPA).
124. LPI - Lightning Protection Institute; www.lightning.org.
125. MBMA - Metal Building Manufacturers Association; www.mbma.com.
126. MCA - Metal Construction Association; www.metalconstruction.org.
127. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
128. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
129. MHI - Material Handling Industry of America; www.mhia.org.
130. MIA - Marble Institute of America; (See NSI).
131. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
132. MPI - Master Painters Institute; www.paintinfo.com.
133. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
134. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
135. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
136. NADCA - National Air Duct Cleaners Association; www.nadca.com.

137. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
138. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
139. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
140. NBI - New Buildings Institute; www.newbuildings.org.
141. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
142. NCMA - National Concrete Masonry Association; www.ncma.org.
143. NEBB - National Environmental Balancing Bureau; www.nebb.org.
144. NECA - National Electrical Contractors Association; www.necanet.org.
145. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
146. NEMA - National Electrical Manufacturers Association; www.nema.org.
147. NETA - InterNational Electrical Testing Association; www.netaworld.org.
148. NFHS - National Federation of State High School Associations; www.nfhs.org.
149. NFPA - National Fire Protection Association; www.nfpa.org.
150. NFPA - NFPA International; (See NFPA).
151. NFRC - National Fenestration Rating Council; www.nfrc.org.
152. NGA - National Glass Association (The); (Formerly: Glass Association of North America); www.glass.org.
153. NHLA - National Hardwood Lumber Association; www.nhla.com.
154. NLGA - National Lumber Grades Authority; www.nlga.org.
155. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
156. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
157. NRCA - National Roofing Contractors Association; www.nrca.net.
158. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
159. NSF - NSF International; www.nsf.org.
160. NSI - National Stone Institute; (Formerly: Marble Institute of America); www.naturalstoneinstitute.org.
161. NSPE - National Society of Professional Engineers; www.nspe.org.
162. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
163. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
164. NWFA - National Wood Flooring Association; www.nwfa.org.
165. NWRA - National Waste & Recycling Association; www.wasterecycling.org
166. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
167. PDI - Plumbing & Drainage Institute; www.pdionline.org.
168. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
169. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
170. RFCI - Resilient Floor Covering Institute; www.rfci.com.
171. RIS - Redwood Inspection Service; www.redwoodinspection.com.
172. SAE - SAE International; www.sae.org.
173. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
174. SDI - Steel Deck Institute; www.sdi.org.
175. SDI - Steel Door Institute; www.steeldoor.org.
176. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
177. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
178. SIA - Security Industry Association; www.siaonline.org.
179. SJI - Steel Joist Institute; www.steeljoist.org.
180. SMA - Screen Manufacturers Association; www.smainfo.org.
181. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
182. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
183. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
184. SPIB - Southern Pine Inspection Bureau; www.spib.org.
185. SPRI - Single Ply Roofing Industry; www.spri.org.
186. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.

187. SSINA - Specialty Steel Industry of North America; www.ssina.com.
188. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
189. STI - Steel Tank Institute; www.steeltank.com.
190. SWI - Steel Window Institute; www.steelwindows.com.
191. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
192. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
193. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
194. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
195. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
196. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
197. TMS - The Masonry Society; www.masonrysociety.org.
198. TPI - Truss Plate Institute; www.tpinst.org.
199. TPI - Turfgrass Producers International; www.turfgrasssod.org.
200. TRI - Tile Roofing Institute; www.tileroofing.org.
201. UL - Underwriters Laboratories Inc.; www.ul.com.
202. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
203. USAV - USA Volleyball; www.usavolleyball.org.
204. USGBC - U.S. Green Building Council; www.usgbc.org.
205. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
206. WA - Wallcoverings Association; www.wallcoverings.org.
207. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
208. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
209. WDMA - Window & Door Manufacturers Association; www.wdma.com.
210. WI - Woodwork Institute; www.wicnet.org.
211. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
212. WWPA - Western Wood Products Association; http://www.wwpa.org.

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
2. ICC - International Code Council; www.iccsafe.org.
3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; www.quicksearch.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov/fdsys.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.

12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeial Convention; www.usp.org.
19. USPS - United States Postal Service; www.usps.com.

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.govinfo.gov.
2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.quicksearch.dla.mil.
3. DSCC - Defense Supply Center Columbus; (See FS).
4. FED-STD - Federal Standard; (See FS).
5. FS - Federal Specification; Available from DLA Document Services; www.quicksearch.dla.mil.

    a. Available from Defense Standardization Program; www.dsp.dla.mil.
    b. Available from General Services Administration; www.gsa.gov.
    c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.

6. MILSPEC - Military Specification and Standards; (See DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for temporary support, security, and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary of Work" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.

B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

C. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.4 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

B. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

1.5 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES

A. Field Offices:

1. Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading, if required by Contractor. Unit must be large enough for regular job meetings, plan review areas, submittal storage and other job file and administrative functions.

a. If provided, Contractor will be responsible for its complete installation.
b. No building space will be provided by the Owner for the Contractor’s field office.

B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

1. Sheds to be metal box storage units or have wood floors raised above the ground.
2. Store combustible materials apart from building.

2.2 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

D. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.

E. Electronic Communication Service: Regardless of availability of Owner's service, the Contractor shall maintain at his expense secure and reliable WiFi wireless connection to internet with provisions for access by Architect, the Owner's staff, Municipal Officials or Inspectors, and all subcontractors.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Provide construction for temporary sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

C. Parking: Provide temporary parking areas for construction personnel.

D. Project Signs: Provide Project signs as indicated and required by Owner. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

    a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touch up signs so they are legible at all times.

E. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

F. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

G. Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

1. Do not load elevators beyond their rated weight capacity.
2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work, so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

H. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

D. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

E. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

B. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Sections:

1. Section 012500 "Substitution Procedures" for requests for substitutions.
2. Section 014200 "References" for applicable industry standards for products specified.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.

2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one (1) week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within fifteen (15) days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.

    a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
    b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two (2) or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
5. Protect stored products from damage and liquids from freezing.
6. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. Refer to Divisions 02 through 49. Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products:

a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one (1) of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered, unless otherwise indicated.
b. Non-Restricted List: Where Specifications include a list of names of both available manufacturers and products, provide one (1) of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.

4. Manufacturers:

a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one (1) of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered, unless otherwise indicated.
b. Non-Restricted List: Where Specifications include a list of available manufacturers, provide a product by one (1) of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.

5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one (1) of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one (1) of the other named manufacturers.

C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed, SIDE-BY-SIDE comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as

performance, weight, size, durability, visual effect, and specific features and requirements indicated.

3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Installation of the Work.
2. Cutting and patching.
3. Progress cleaning.
4. Starting and adjusting.
5. Protection of installed construction.
6. Correction of the Work.

B. Related Sections:

1. Section 013300 "Submittal Procedures" for submitting surveys.
2. Section 017700 "Closeout Procedures" for recording of Owner-accepted deviations from indicated lines and levels and final cleaning.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from the Architect before proceeding. Shore, brace, and support structural element during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to the Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of utilities and construction indicated as existing are not guaranteed.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

a. Description of the Work.
b. List of detrimental conditions, including substrates.
c. List of unacceptable installation tolerances.
d. Recommended corrections.

2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of the Contractor, submit a request for information to Architect according to requirements in Section 013100 "Project Management and Coordination."

3.3 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
2. Allow for building movement, including thermal expansion and contraction.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.4 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Temporary Support: Provide temporary support of work to be cut.

C. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

D. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching.

E. Existing Utility Services: Where existing services are required to be removed, relocated, or abandoned, bypass such systems before cutting to minimize interruption to occupied areas.

F. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
5. Proceed with patching after construction operations requiring cutting are complete.

G. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.

a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

    a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.5 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven (7) days during normal weather or three (3) days if the temperature is expected to rise above 80 deg F (27 deg C).
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

    a. Utilize containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where more than one installer has worked.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.6 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.8 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their specified condition.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.

B. Related Sections:

1. Section 017300 "Execution" for progress cleaning of Project site.
2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
3. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
4. Section 017900 "Demonstration and Training" for requirements for instructing Owner's personnel.
5. Divisions 02 through 49 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete with request.

1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
2. Advise Owner of pending insurance changeover requirements.
3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Prepare and submit Project Record Documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
8. Complete startup testing of systems.
9. Submit test/adjust/balance records.
10. Terminate and remove temporary facilities from Project site, along with construction tools and similar elements.
11. Advise Owner of changeover in heat and other utilities.

12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Section 012900 "Payment Procedures".
2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
5. Secure and provide both temporary and final Certificate of Occupancy from the Building Official, meeting all local and state permit closeout requirements.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use **CSI Form 14.1A** or comparable form.

1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

a. Project name.
b. Date.
c. Name of Architect.
d. Name of Contractor.
e. Page number.

4. Submit list of incomplete items in the following format:

a. PDF electronic file. Architect will return annotated file.

1.6 WARRANTIES

A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

B. Partial Occupancy: Submit properly executed warranties within fifteen (15) days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8½-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
4. Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide table of contents at beginning of document.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION (Not Used)

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Systems and equipment operation manuals.
4. Systems and equipment maintenance manuals.
5. Product maintenance manuals.

B. Related Sections:

1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual specification sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:

1. Two (2) thumb drives. Enable review comments on draft submittals.
2. Two (2) paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Architect will return both copies to be given to the Owner.

C. Initial Manual Submittal: Submit draft copy of each manual at least thirty (30) days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least fifteen (15) days before commencing demonstration and training. Architect will return copy with comments.

1. Correct or modify each manual to comply with Architect's comments. Submit copies of each corrected manual within fifteen (15) days of receipt of Architect's comments and prior to commencing demonstration and training.

E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8½-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. If two (2) or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8½-by-11-inch white bond paper.

5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Architect.
7. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one (1) volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one (1) system into a single binder.

1.7 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.

5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one (1) item in a tabular format,

identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Sections:

1. Section 017700 "Closeout Procedures" for general closeout procedures.
2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
3. Divisions 02 through 49 Sections for specific requirements for project record documents of the Work in those Sections.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit one (1) set(s) of marked-up record prints.

B. Record Specifications: Submit one (1) paper copy of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit one (1) paper copy of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one (1) set of marked-up paper copies of the Contract Drawings and Shop Drawings.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Revisions to routing of piping and conduits.
d. Revisions to electrical circuitry.
e. Actual equipment locations.
f. Duct size and routing.
g. Locations of concealed internal utilities.
h. Changes made by Change Order or Construction Change Directive.
i. Changes made following Architect's written orders.
j. Details not on the original Contract Drawings.
k. Field records for variable and concealed conditions.
l. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Paper copy.
3. Identification: As follows:

a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Architect.
e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
5. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as paper copy.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Format: Submit record Product Data as paper copy.

1. Include record Product Data directory organized by specification section number and title, electronically linked to each item of record Product Data.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one (1) copy of each submittal during the construction period for project record document purposes. Post changes and modifications to project record documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.

B. Related Sections:

1. Divisions 02 through 49 Sections for specific requirements for demonstration and training for products in those Sections.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules utilizing manufacturer-produced demonstration for systems, equipment, and products in lieu of video recording of live instructional module.

B. Attendance Record: For each training module, submit list of participants and length of instruction time.

C. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Pre-Instruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Operations manuals.
    c. Maintenance manuals.
    d. Project record documents.
    e. Identification systems.
    f. Warranties and bonds.
    g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operations and Maintenance Data."

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner with at least seven (7) days advance notice.

D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test and ask Owner to sign-off on for acceptance.

E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 017900

SECTION 024119 - SELECTIVE DEMOLITION

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. Demolition and removal of selected portions of building or structure.
2. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 011000 "Summary of Work" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 017300 "Execution" for cutting and patching procedures.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Remove and Replace: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled. Provide and install new items as specified.

E. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

F. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PRE-INSTALLATION MEETINGS

A. Pre-demolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Pre-demolition Photographs: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.

E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

F. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract. Contractor will be required to coordinate with Owner’s vendor.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.10 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:

1. Ethylene-Propylene-Diene-Monomer (EPDM) roofing by Johns Manville.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.11 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

1. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs.

1. Comply with requirements specified in Section 013233 "Photographic Documentation."
2. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.

c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
8. All removed materials and rubbish shall be constantly sprinkled with water or other dusting agent to mitigate dust. Provide drop cloths or other type of coverings to prevent infiltration of dust to other parts of the existing building.
9. Dispose of demolished items and materials promptly.

B. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

B. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings/Retaining wall.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one (1) or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

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

B. Shop Drawings:

1. Shop drawings will not be accepted for review by the Architect unless there is substantial evidence that the General Contractor or Construction Manager on the project has reviewed the submittal for compliance with the contract documents and has addressed questions to be responded to by the Contractor. All coordination items with other trades and submittals are to be performed and the submittal marked accordingly before submission. Failure to provide the above will result in the submittal being returned and not reviewed.
2. Shop drawings shall be submitted in the form of an electronic file (PDF).
3. The following is the definitions for the Shop Drawing stamp disposition:

    a. **No Exceptions Taken** - Re-submission is not required unless document is revised.
    b. **Make Corrections Noted** - Contractor is responsible for making noted corrections. Re-submission of record copies are required.
    c. **Revise and Resubmit** - Resubmit corrected copies for final review, with all changes clouded.
    d. **Rejected** - Resubmit for review.
    e. **Reviewed** – Reviewed for general compliance with the Contract Documents. Resubmission is not required.

    Corrections or comments made on shop drawings during this review do not relieve the Contractor from compliance with the requirements of the project drawings and specifications. This check is only for the review of general conformance with the information given in the Contract Documents. The Contractor is responsible for confirming and correlating all quantities and dimensions, selecting fabrication processes, techniques and sequence of construction, coordinating his work with that of other trades, and performing his work in accordance with OSHA requirements and other sections of the Project Specifications.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

E. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.
4. Curing compounds.
5. Bonding agents.
6. Adhesives.
7. Semi-rigid joint filler.
8. Repair materials.

F. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates.

G. Field quality-control reports.

H. Minutes of pre-installation conference.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

E. Pre-installation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Concrete subcontractor.
    e. Special concrete finish subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

    a. High-density overlay, Class 1 or better.
    b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    c. Structural 1, B-B or better; mill oiled and edge sealed.
    d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, ¾-by-¾-inch, minimum.

D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1-inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1-inch in diameter in concrete surface.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60 (Grade 420), deformed.

B. Deformed-Steel Wire: ASTM A 496.

C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as drawn steel wire into flat sheets.

D. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884, Class A coated, Type 1, plain steel.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A 615, Grade 60 (Grade 420), plain-steel bars, ASTM A 775 epoxy coated.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150 Type I/II, gray. Supplement with the following:

a. Fly Ash: ASTM C 618, Class F or C.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C 595, Type IS, Portland blast-furnace slag.

B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least ten (10) years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: ¾-inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94 and potable.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494, Type A.
2. Retarding Admixture: ASTM C 494, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

2.6 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, ¾-by-1-inch.

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. Carlisle Coatings & Waterproofing, Inc.; **MiraSTOP**
b. CETCO; Volclay **Waterstop-RX**
c. Concrete Sealants Inc.; **Conseal CS-231**
d. Greenstreak; **Swellstop**
e. Henry Company, Sealants Division; **Hydro-Flex**
f. JP Specialties, Inc.; **Earth Shield Type 20**

2.7 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

2.8 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034-inch-thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.9 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than forty percent (40%).

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, and concrete with a water cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings and Retaining Walls: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4500 psi at twenty-eight (28) days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1-inch.
4. Air Content: Six percent (6%), plus or minus one and one-half percent (+/-1.5%) at point of delivery for ¾-inch nominal maximum aggregate size.

2.11 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement per CRSI's "Manual of Standard Practice."

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete per ASTM C 94 and ASTM C 1116, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1½ hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8-inch for smooth-formed finished surfaces.
2. Class B, ¼-inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Do not chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

    a. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Form keyed joints as indicated. Embed keys at least 1½ inches into concrete.
2. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Doweled Joints: Install diamond dowel and support assemblies at joints where indicated.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

F. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one (1) day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one (1) part Portland cement to one and one-half (1½) parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3.8 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with inplace construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot weather protection during curing.

B. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven (7) days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven (7) days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.10 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one (1) month. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.11 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one (1) part Portland cement to two and one-half (2½) parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than ½-inch in any dimension to solid concrete. Limit cut depth to ¾-inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

E. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.12 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. B. Inspections:

1. Steel reinforcement placement.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.

B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one (1) composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one (1) set for each additional 50 cu. yd. or fraction thereof.
2. Slump: ASTM C 143; one (1) test at point of placement for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one (1) test for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064; one (1) test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one (1) test for each composite sample.
5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one (1) test for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture.
6. Compression Test Specimens: ASTM C 31.

    a. Cast and laboratory cure two (2) sets of two (2) standard cylinder specimens for each composite sample.
    b. Cast and field cure two (2) sets of two (2) standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C 39; test one (1) set of two (2) laboratory-cured specimens at seven (7) days and one (1) set of two (2) specimens at twenty-eight (28) days.

    a. Test one (1) set of two (2) field-cured specimens at seven (7) days and one (1) set of two (2) specimens at twenty-eight (28) days.
    b. A compressive-strength test shall be the average compressive strength from a set of two (2) specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than eighty-five percent (85%) of companion laboratory cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three (3) consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
10. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at twenty-eight (28) days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
11. Non-destructive Testing: Impact hammer, sonoscope, or other non-destructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.

13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 033000

SECTION 042200 - CONCRETE UNIT MASONRY

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. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry-joint reinforcement.
5. Miscellaneous masonry accessories.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include material test reports substantiating compliance with requirements.

2. Cementitious materials. Include name of manufacturer, brand name, and type.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.

6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109 for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three (3) days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.3 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bullnose units for outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.

1. Density Classification: Normal weight.
2. Size (Width): Manufactured to dimensions 3/8-inch less-than-nominal dimensions.

2.4 MASONRY LINTELS

A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C 207, Type S.

C. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than ¼-inch-thick, use aggregate graded with one hundred percent (100%) passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

D. Aggregate for Grout: ASTM C 404.

E. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615 or ASTM A 996, Grade 60.

B. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A 951.

1. Interior Walls: Hot-dip galvanized carbon steel.
2. Wire Size for Side Rods: 0.148-inch diameter.
3. Wire Size for Cross Rods: 0.148-inch diameter.
4. Spacing of Cross Rods: Not more than 16 inches o.c.
5. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

2.7 TIES AND ANCHORS

A. General: Ties and anchors shall extend at least 1½ inches into masonry but with at least a 5/8-inch cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Stainless-Steel Wire: ASTM A 580, Type 304.
2. Stainless-Steel Sheet: ASTM A 240 or ASTM A 666, Type 304.

C. Partition Top Anchors: 0.105-inch-thick metal plate with a 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from stainless-steel.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to thirty-five percent (35%); of width and thickness indicated; formulated from closed cell PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.9 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use Portland cement-lime mortar unless otherwise indicated.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For reinforced masonry, use Type S.
2. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
3. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that would impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.

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

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus ½-inch or minus ¼-inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus ½-inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus ¼-inch in a story height or ½-inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than ¼-inch in 10 feet, or ½-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8-inch in 10 feet, ¼-inch in 20 feet, or ½-inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than ¼-inch in 10 feet, 3/8-inch in 20 feet, or ½-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8-inch in 10 feet, ¼-inch in 20 feet, or ½-inch maximum.
5. For lines and surfaces, do not vary from straight by more than ¼-inch in 10 feet, 3/8-inch in 20 feet, or ½-inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than ¼-inch in 10 feet, or ½-inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8-inch, with a maximum thickness limited to ½-inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8-inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8-inch or minus ¼-inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8-inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8-inch.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide ½-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.

3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in grouted masonry, including starting course on footings.
3. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8-inch on exterior side of walls, ½-inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Install preformed control-joint gaskets designed to fit standard sash block.

3.8 LINTELS

A. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.9 REINFORCED UNIT MASONRY INSTALLATION

A. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

B. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.10 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to Level C in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Frequency: One (1) set of tests for each 5000-sq. ft. of wall area or portion thereof.

D. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

E. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

F. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

G. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.11 CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.12 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

SECTION 055000 - METAL FABRICATIONS

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. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Metal bollards.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.

C. Related Requirements:

1. Section 042200 "Concrete Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Metal bollards.

A. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connection. Show anchorage and accessory items.

B. Provide Shop Drawings for the following:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Metal bollards.
4. Loose steel lintels.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Research Reports: For post-installed anchors.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1, "Structural Welding Code - Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36.

C. Steel Tubing: ASTM A 500, cold-formed steel tubing.

D. Steel Pipe: ASTM A 53, Standard Weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F 3125, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A 563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Capable of sustaining, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and four (4) times the load imposed when installed in

concrete, as determined by testing in accordance with ASTM E 488, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

H. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless-Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Division 09 sections.

B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Shrinkage-Resistant Grout: Factory-packaged, non-metallic, non-staining, non-corrosive, non-gaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

F. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" on Structural Drawings for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32-inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated, coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports.

2.7 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe.

B. Fabricate sleeves for bollard anchorage from steel or stainless-steel pipe or tubing with ¼-inch-thick, steel or stainless-steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and ¾-inch larger than OD of bollard.

C. Galvanize and prime.

2.8 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches unless otherwise indicated.

C. Galvanize and prime loose steel lintels located in exterior walls.

D. Prime interior loose steel lintels.

2.9 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.10 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153 for steel and iron hardware and with ASTM A 123 for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 INSTALLATION OF METAL BOLLARDS

B. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8-inch toward bollard.

B. Fill bollards solidly with concrete, mounding top surface to shed water.

3.4 REPAIRS

A. Touchup Painting:

1. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 sections.

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

END OF SECTION 055000

SECTION 055119 - METAL GRATING STAIRS

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 industrial-type, straight-run stairs with steel-grating treads and associated platform.

1.3 COORDINATION

A. Coordinate installation of anchorages for metal stairs.

1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
2. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For metal grating stairs and the following:

1. Gratings.
2. Grout.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.

C. Third-Party Review Submittal: For stairs, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing third-party review services of the kind indicated, including documentation that engineer is licensed in the State in which Project is located.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification.

1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
2. Protect steel members and packaged materials from corrosion and deterioration.
3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Third-Party Review: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to review the load calculations of the stair and railing assemblies.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360.

C. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36.

C. Rolled-Steel Floor Plate: ASTM A 786, rolled from plate complying with ASTM A 36 or ASTM A 283, Grade C or D.

D. Steel Bars for Grating Treads: ASTM A 36 or steel strip, ASTM A 1011 or ASTM A 1018.

E. Steel Wire Rod for Grating Crossbars: ASTM A 510.

2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 where built into exterior walls.

1. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for stairs indicated to be galvanized.

D. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and four (4) times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

2.4 MISCELLANEOUS MATERIALS

A. Welding Electrodes: Comply with AWS requirements.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Non-metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, non-metallic aggregate grout; recommended by manufacturer for interior use; non-corrosive and non-staining; mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, railings, guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Assemble stairs, railings, and platform in shop to greatest extent possible.

1. Disassemble units only as necessary for shipping and handling limitations.
2. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately 1/32-inch unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply 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. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #4 – Good quality, uniform undressed weld with minimal splatter.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.

1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
2. Locate joints where least conspicuous.
3. Fabricate joints that are exposed to weather in a manner to exclude water.
4. Provide weep holes where water may accumulate internally.

2.6 FABRICATION OF STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Industrial Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel channels.

a. Provide closures for exposed ends of channel stringers.

2. Construct platforms and tread supports of steel channel headers and miscellaneous framing members as required to comply with “Performance Requirements” Article.

a. Provide closures for exposed ends of channel framing.

3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers.

C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from welded or pressure-locked steel grating with openings in gratings no more than ½-inch in least dimension.

a. Surface: Serrated.

2. Fabricate grating treads with rolled-steel floor plate nosing and with steel angle or steel plate carrier at each end for stringer connections.

a. Secure treads to stringers with bolts.

3. Fabricate grating platforms with nosing matching that on grating treads.

a. Secure grating to platform framing by welding.

D. Risers: Open.

2.7 FABRICATION OF STAIR RAILINGS

A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."

2.8 FINISHES

A. Finish metal stairs after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153 for steel and iron hardware and with ASTM A 123 for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

D. Shop Primers, Intermediate Coats, and Topcoats: Provide products that comply with Section Section 099123 "Interior Painting."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.

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

3.2 INSTALLING METAL STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.

1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

1. Grouted Baseplates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces.

a. Clean bottom surface of baseplates.
b. Set steel-stair baseplates on wedges, shims, or leveling nuts.
c. After stairs have been positioned and aligned, tighten anchor bolts.
d. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.
e. Promptly pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

1) Neatly finish exposed surfaces; protect grout and allow to cure.
2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
2. Comply with requirements for welding in "Fabrication, General" Article.

3.3 REPAIR

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

END OF SECTION 055119

SECTION 055213 - PIPE AND TUBE RAILINGS

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. Steel pipe railings.

1.3 COORDINATION

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Grout and anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.

D. Third-Party Review Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency and for professional engineer's experience with providing third-party review services of the kind indicated, including documentation that engineer is licensed in the State in which Project is located.

B. Welding certificates.

C. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

D. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Third-Party Review: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to review load calculations of the railing assemblies, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C, material surfaces).

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.3 STEEL AND IRON

A. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5.

B. Pipe: ASTM A 53, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

C. Plates, Shapes, and Bars: ASTM A 36.

2.4 FASTENERS

A. General: Provide the following:

1. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153 or ASTM F 2329 for zinc coating.
2. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
2. Provide Phillips tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and four (4) times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless-Steel Is Indicated: Alloy Group stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Shop Primers, Intermediate Coats, and Topcoats: Provide products that comply with Sections 099113 “Exterior Painting” and 099123 "Interior Painting."

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

F. Non-Shrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32-inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

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 flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Form Changes in Direction as Follows:

1. As detailed.

J. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

K. Close exposed ends of railing members with prefabricated end fittings.

L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is ¼-inch or less.

M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

N. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

O. For railing posts set in concrete, provide stainless-steel sleeves not less than 6 inches long with inside dimensions not less than ½-inch greater than outside dimensions of post, with metal plate forming bottom closure.

2.7 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
2. Comply with ASTM A 123 for hot-dip galvanized railings.
3. Comply with ASTM A 153 for hot-dip galvanized hardware.
4. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

D. Shop-Painted Finish: Comply with Sections 099113 “Exterior Painting” and 099123 “Interior Painting."

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16-inch in 3 feet.

3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed ¼-inch in 12 feet.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.3 ANCHORING POSTS

A. Use metal collars preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with non-shrink, non-metallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Leave anchorage joint exposed with 1/8-inch buildup, sloped away from post for exterior locations and flush with adjacent surface for interior locations.

C. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

3.4 ATTACHING RAILINGS

B. Secure wall brackets and railing end flanges to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.

3.5 CLEANING

A. Clean by washing thoroughly with clean water and soap and rinsing with clean water.

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

3.6 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213

SECTION 078413 - PENETRATION FIRESTOPPING

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. Fireproof firestopping and firesafing materials and accessories.

1.3 PERFORMANCE REQUIREMENTS

A. Fireproofing Materials: ASTM E 119 and ASTM E 814 to achieve a fire rating as noted on Drawings.

B. Surface Burning: ASTM E 84 with a flame spread/fuel contributed/smoke developed rating of 5/0/0.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated provide characteristics, performance, and limitation criteria.

B. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three (3) years documented experience.

B. Applicator: Company specializing in performing the work of this Section with minimum five (5) years documented experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to applicable State Building code for fire resistance ratings and surface burning characteristics.

B. UL Classifications for these systems shall be (all two (2) hours or more):

1. Duct Penetrations: C-AJ-7027
2. Pipe Penetrations: C-AJ-1079
3. Cable Penetrations: C-AJ-1079
4. Conduit Penetrations: C-AJ-1079

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not apply materials when temperature of substrate material and ambient air is below 60 degrees F.

B. Maintain this minimum temperature before, during and for three (3) days after installation of materials.

C. Provide ventilation in areas to receive solvent cured materials.

1.8 SEQUENCING

A. Sequence Work to permit firestopping materials to be installed after adjacent and surrounding work is complete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Thermal Ceramics; **Firemaster Putty, Bulk, and Blankets**

B. Tremco Incorporated; **Fyre-shield and Cerablanket FS Hilti, Inc.**

C. United States Gypsum; **Thermafiber Safing Insulation and FIRECODE compound**

D. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

2.2 MATERIALS

A. Firestopping Material: Single component silicone elastomeric compounds; conforming to the following:

1. Elongation & Shrinkage: Five percent (5%).
2. Tensile Strength: 300 psi.
3. Density: 8 lb/cu ft.
4. Surface Durability: 35 (Shore Hardness).
5. Durability and Longevity: Permanent.
6. Side Effects during Installation: Non-toxic.
7. Long Term Side Effects: None.

B. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces.

C. Firesafing Blankets: ASTM C 665; 4 psf nominal density firesafing insulation.

D. Putty Pads: UL CLIV; acoustic, intumescent pad; 3.2mm thickness.

2.3 ACCESSORIES

A. Dam Material: Mineral fiber matting, permanent.

B. Retainers: Stainless clips to support mineral fiber matting

2.4 FINISHES

A. Color: Dark gray or manufacturer’s standard color.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Install backing materials to arrest liquid material leakage.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Apply firestopping material to all wall and floor penetrations through rated assemblies. These penetrations include electrical conduit and raceways, plumbing and heating system penetrations, ducts, and other system chases.

C. Apply primer and materials in accordance with manufacturer's instructions.

D. Apply firestopping material in sufficient thickness to achieve rating to a density of fifty percent (50%) to uniform density and texture.

E. Install material at walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit, and other items requiring firestopping.

F. Remove dam material after firestopping material has cured.

3.4 CLEANING AND PROTECTION

A. Clean off excess materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

3.5 SCHEDULE

A. See Construction Documents for rating information and construction details and conditions.

B. Firesafe all penetrations through new and existing masonry and gypsum board construction in the project work areas, equal to the one (1) or two (2) hour rating of the appropriate spaces.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

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. Silicone joint sealants.
2. Latex joint sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

D. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

B. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:

1. Architectural sealants shall have a VOC content of 250 g/L or less.

C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

D. Stain-Test-Response Characteristics: Where sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

E. Colors of Exposed Joint Sealants: As selected by Architect and Owner from manufacturer's entire range, to match adjacent where required.

2.2 SILICONE JOINT SEALANTS

A. Silicone, Non-Staining: Non-Staining, single-component, non-sag, plus fifty percent (+50%) and minus fifty percent (-50%) movement capability, non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

1. Products:

a. Dow Corning Corporation
b. Master Bond, Inc.
c. Pecora Corporation
d. Tremco Incorporated
e. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

2.3 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

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. BASF Building Systems; **Sonolac**
b. Bostik, Inc.; **Chem-Calk 600**
c. Pecora Corporation; **AC-20+**
d. Tremco Incorporated; **Tremflex 834**
e. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

2.4 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type B (bi-cellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Non-Sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.

a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:

a. Other joints as indicated.

2. Joint Sealant: Silicone, non-staining, S, NS, 50, NT.

B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:

a. Vertical joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
b. Other joints as indicated.

2. Joint Sealant: Latex.

END OF SECTION 079200

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

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. Non-load-bearing steel framing for interior partitions.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For firestop tracks, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: ASTM A 653, G60, hot-dip galvanized unless otherwise indicated.

B. Studs and Tracks: ASTM C 645.

1. Steel Studs and Tracks:

a. Minimum Base-Metal Thickness: 20-gauge, unless noted otherwise.
b. Depth: As indicated on Drawings.

C. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

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. ClarkDietrich; **BlazeFrame DSL**
b. Fire Trak Corp.; **Fire Trak System**
c. Metal-Lite, Inc.; **The System**
d. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Rigid Connections: Universal framing clip to attach and support rigid framing conditions including shear, tension, and two-axis loading.

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. Dietrich Metal Framing; **Uni-Clip**.
b. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

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

3.2 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

3.3 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Install studs so flanges within framing system point in same direction.

C. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

2. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8-inch from the plane formed by faces of adjacent framing.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

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. Interior gypsum board.

B. Related Requirements:

1. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Georgia-Pacific Gypsum LLC
2. National Gypsum Company
3. USG Corporation
4. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

B. Abuse-Resistant Gypsum Board: ASTM C 1629.

1. Core: As indicated on Drawings.
2. Surface Abrasion: Meets or exceeds Level 3 requirements.
3. Surface Indentation: Meets or exceeds Level 1 requirements.
4. Single-Drop Soft-Body Impact: Meets or exceeds Level 1 requirements.
5. Long Edges: Tapered.
6. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:

a. Cornerbead.
b. Bullnose bead.
c. LC-Bead: J-shaped; exposed long flange receives joint compound.
d. L-Bead: L-shaped; exposed long flange receives joint compound.
e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
f. Expansion (control) joint.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033- to 0.112-inch-thick.

C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

D. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

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. Pecora Corporation; **AC-20 FTR**
b. Specified Technologies, Inc.; **Smoke N Sound Acoustical Sealant**
c. USG Corporation; **SHEETROCK Acoustical Sealant**
d. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

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

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16-inch of open space between panels. Do not force into place.

C. Locate edge and end joints over supports. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

D. Form control and expansion joints with space between edges of adjoining gypsum panels.

E. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow ¼- to 3/8-inch-wide joints to install sealant.

F. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide ¼- to ½-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

H. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

I. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board where indicated on Drawings.

B. Single-Layer Application:

1. On partitions/walls, apply gypsum panels in most economical direction, with ends and edges occurring over firm bearing unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one (1) framing member in alternate courses of panels.

2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multi-layer Application:

1. On partitions/walls, apply gypsum board indicated for base layers horizontally (perpendicular to framing) and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one (1) stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
2. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners, unless otherwise indicated.
2. Bullnose Bead: Use at outside corners.
3. LC-Bead: Use at exposed panel edges.
4. L-Bead: Use where indicated.
5. U-Bead: Use at exposed panel edges.

3.5 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 4: At panel surfaces that will be exposed to view, receiving wallcoverings, flat, and non-flat paints.

a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.6 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

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 acoustical panels and exposed suspension systems for ceilings.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which suspension systems will be attached.
3. Size and location of initial access modules for acoustical panels.
4. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

B. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.

C. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Panels: Full-size panels equal to two percent (2%) of each type of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to two percent (2%) of quantity installed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANELS, GENERAL

A. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
2. Suspension System: Obtain each type from single source from single manufacturer.

B. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15¾ inches away from test surface according to ASTM E 795.

C. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL PANEL MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong World Industries, Inc.
2. CertainTeed Corp.
3. Decoustics
4. Frasch!, a Catalyst Acoustics Group company
5. USG Interiors, Inc.; Subsidiary of USG Corporation
6. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

2.4 ACOUSTICAL PANELS

A. Basis-of-Design Product:

1. Armstrong World Industries, Inc.; **Ultima**
2. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:

a. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted; with vinyl overlay on face, back, and sealed edges.
b. Pattern: E (lightly textured).

3. Color: White.
4. LR: Not less than 0.88.
5. NRC: Not less than 0.75.
6. Edge/Joint Detail: Square lay-in.
7. Thickness: ¾-inch.
8. Modular Size: 24 by 24 inches.

B. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.5 METAL SUSPENSION SYSTEM

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong World Industries, Inc.
2. CertainTeed Corp.
3. Decoustics
4. USG Interiors, Inc.; Subsidiary of USG Corporation

5. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

B. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.

1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

C. Wide-Face, Double-Web, Hot-Dip Galvanized, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; hot-dip galvanized according to ASTM A 653; with prefinished, cold-rolled, 15/16-inch-wide flanges.

1. Basis-of-Design Product:

a. Armstrong World Industries, Inc.; **Prelude XL 15/16-Inch Exposed Tee System**

2. Structural Classification: Heavy-duty system.
3. Face Design: Flat, flush.
4. Finish: Painted white, unless otherwise indicated in Section 090000 “Schedule of Finishes”.

2.6 ACCESSORIES

A. Attachment Devices: Size for five (5) times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Provide manufacturer’s standard fasteners and hooks.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641, Class 1 zinc coating, soft temper.
2. Size: Select wire diameter so its stress at three (3) times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch-diameter wire.

C. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place.

D. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

E. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

2.7 METAL EDGE MOLDINGS AND TRIM

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong World Industries, Inc.
2. CertainTeed Corp.
3. USG Interiors, Inc.; Subsidiary of USG Corporation
4. Substitutions: Under provisions of Division 01 Section “Substitution Procedures”.

B. Roll-Formed, Sheet-Metal Edge Moldings: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.8 ACOUSTICAL SEALANT

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

1. Acoustical Sealant for Exposed and Concealed Joints:

a. Pecora Corporation; **AC-20 FTR Acoustical and Insulation Sealant**
b. USG Corporation; **SHEETROCK Acoustical Sealant**
c. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Exposed and Concealed Joints: Non-sag, paintable, non-staining latex sealant.
2. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

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

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three (3) tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
6. Do not attach hangers to roof deck. Attach hangers to structural members.
7. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
8. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four (4) tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8-inch in 12 feet. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.

2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
3. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Resilient base.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

C. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

1.7 WARRANTY

A. Provide manufacturer's written limited warranties against defects in materials and against premature wear prior to warranty expiration for the materials as follows:

1. Resilient Base: Two (2) years.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Conform to Class I rating with a flame spread of 0 to 25 in accordance with the requirements of Class A material in accordance with ASTM E 84. Rubber products shall be Class I, 0.45 watts/sq. cm in accordance with ASTM E 648 and NFPA 255.

2.2 THERMOPLASTIC-RUBBER BASE

A. Basis-of-Design:

1. Roppe Corporation, USA**; Pinnacle Rubber Base**

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Burke Mercer Flooring Products, Division of Burke Industries Inc.
2. Flexco Corporation
3. Johnsonite; a Tarkett Company
4. Mannington Mills, Inc.
5. Substitutions: Under provisions of Section 016310 “Equals and Substitutions”.

C. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).

1. Group: I (solid, homogeneous).
2. Style: B, Cove.

D. Thickness: 0.125-inch.

E. Height: 4 inches, but to match existing.

F. Lengths: Coils in manufacturer's standard length.

G. Outside and Inside Corners: Preformed.

H. Colors: As selected by Architect and Owner from manufacturer’s entire range, but to match existing.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

1. Adhesives shall have a VOC content of 50 g/L or less except that adhesive for rubber stair treads shall have a VOC content of 60 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

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

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until they are the same temperature as the space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from exposed surfaces.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 099113 - EXTERIOR PAINTING

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 surface preparation and the application of paint systems on the following exterior substrates:

1. Steel and iron.
2. Galvanized metal.

1.3 DEFINITIONS

A. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

C. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: Five percent, (5%) but not less than 1 gal. of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds eighty-five percent (85%); at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Behr Process Corporation
2. Benjamin Moore & Co.
3. Duron, Inc.
4. ICI Paints
5. PPG Architectural Finishes, Inc.
6. Sherwin-Williams Company (The)
7. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

D. Colors: As selected by Architect and Owner from manufacturer’s entire range, to match existing where required.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.

3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two (2) paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 3.

E. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
3. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
4. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view, unless factory-finished:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Steel and Iron Substrates:

1. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer, zinc rich, inorganic, **MPI #19**.
b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (Gloss Level 5), **MPI #163**.

B. Galvanized-Metal Substrates:

1. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer, galvanized, water based**, MPI #134**.
b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (Gloss Level 5), **MPI #163**.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

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 surface preparation and the application of paint systems on the following interior substrates:

1. Concrete masonry units (CMU).
2. Steel and iron.
3. Galvanized metal.
4. Gypsum board.

B. Related Requirements:

1. Section 099113 "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

1.3 DEFINITIONS

A. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Samples: For each type of paint system and in each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: Five percent (5%), but not less than 1 gal. of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints when relative humidity exceeds eighty-five percent (85%); at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Benjamin Moore & Co.
2. ICI Paints
3. Sherwin-Williams Company (The)
4. Substitutions: Under provisions of Section 016310 “Equals and Substitutions”.

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Non-Flat Paints and Coatings: 150 g/L.

2. Primers, Sealers, and Undercoaters: 200 g/L.
3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
4. Zinc-Rich Industrial Maintenance Primers: 340 g/L.

D. Colors: As selected by Architect and Owner from manufacturer's entire range, to match existing where required.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two (2) paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Masonry (Clay and CMUs): Twelve percent (12%).
2. Gypsum Board: Twelve percent (12%).

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

E. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 3, "Power Tool Cleaning."

F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms, unless factory-finished:

    a. Equipment, including panelboards.
    b. Uninsulated metal piping.
    c. Uninsulated plastic piping.
    d. Pipe hangers and supports.
    e. Metal conduit.
    f. Plastic conduit.
    g. Tanks that do not have factory-applied final finishes.
    h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed in occupied spaces, unless factory-finished:

    a. Equipment, including panelboards.
    b. Uninsulated metal piping.
    c. Uninsulated plastic piping.
    d. Pipe hangers and supports.
    e. Metal conduit.
    f. Plastic conduit.
    g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
    h. Other items as directed by Architect.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. Latex System:

a. Block Filler: Block filler, latex, interior/exterior, **MPI #4**.
b. Intermediate Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, eggshell, (Gloss Level 3), **MPI #52**.

B. Steel Substrates:

1. Latex System, Alkyd Primer:

a. Prime Coat: Primer, alkyd, quick dry, for metal, **MPI #76**.
b. Intermediate Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, semi-gloss (Gloss Level 5), **MPI #54**.

C. Galvanized-Metal Substrates:

1. Latex System:

a. Prime Coat: Primer, galvanized, water based, **MPI #134**.
b. Intermediate Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, semi-gloss (Gloss Level 5), **MPI #54**.

D. Gypsum Board Substrates:

1. Latex System:

a. Prime Coat: Primer sealer, latex, interior, **MPI #50**.
b. Intermediate Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, eggshell, (Gloss Level 3), **MPI #52**.

END OF SECTION 099123

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

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. Solid surface material countertops.

1.3 ACTION SUBMITTALS

A. Product Data: For solid surfacing materials.

B. Shop Drawings: For countertops. Show materials, finishes, edge profiles, and methods of joining.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

C. Samples: For the following products:

1. Solid surfacing material, 6 inches square.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For solid surface materials to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate solid surface materials similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

PART 2 - PRODUCTS

2.1 SOLID SURFACE MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.

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

a. Avonite Surfaces by Aristech Acrylics LLC
b. E. I. du Pont de Nemours and Company
c. Formica Corporation
d. LG Chemical, Ltd.
e. Wilsonart International
f. Substitutions: Under provisions of Section 012500 “Substitution Procedures”.

2. Type: Provide Standard type unless Special Purpose type is indicated.
3. Colors and Patterns: As selected by Architect and Owner from manufacturer’s entire range, to match existing where required.

B. Medium-Density Fiberboard: ANSI A208.2, Grade 130, made for wet environments, fire-rated.

2.2 FABRICATION

A. Fabricate according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Grade: **Custom**.

B. Configuration:

1. Front: Bullnose edge.

C. Countertops: ½-inch-thick, solid surface material with front edge built up with same material.

D. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

E. Joints: Fabricate countertops without joints.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.

1. Adhesives shall not contain urea formaldehyde.

B. Sealant: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive solid surface material countertops and conditions under which material will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION

A. Install countertops level to a tolerance of 1/8-inch in 8 feet, ¼-inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.

B. Fasten subtops to structure by screwing through subtops into studs. Shim as needed to align subtops in a level plane.

C. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

D. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Sleeves shall be in accordance with NFPA 13.

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

C. Galvanized-Steel Wall Pipes: ASTM A 53, Schedule 40, with plain ends and welded steel collar; zinc coated.

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

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

2.2 STACK-SLEEVE FITTINGS

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

1. Jay R. Smith Mfg. Co.
2. Zurn Industries, LLC

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company
4. Metraflex Company (The)
5. Proco Products, Inc.

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

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company
4. Metraflex Company (The)
5. Proco Products, Inc.

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

2.5 GROUT

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

B. Characteristics: Non-shrink; recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

1. Sleeves are not required for core-drilled holes.

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

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

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

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

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping." Fire seal shall be UL listed, approved, and tested fire and/or smoke sealing material installed in all fire and/or smoke rated floor and partitions in accordance with NFPA, local code, and manufacturers recommendations.

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble

sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

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

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

C. Secure nailing flanges to concrete forms.

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

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with Sleeve-seal fittings.
b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with Sleeve-seal fittings.

2. Exterior Concrete Walls below Grade:

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

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

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

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

3. Concrete Slabs-on-Grade:

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

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

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

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

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves or Sleeve-seal fittings.
b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves or Sleeve-seal fittings

5. Interior Partitions:

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

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

END OF SECTION 210517

SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for 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.
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.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
f. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 210518

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Sprinklers.

1.3 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig, but not higher than 300 psig.

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

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

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Compressed air piping.
3. HVAC hydronic piping.
4. Items penetrating finished ceiling include the following:

a. Lighting fixtures.
b. Air outlets and inlets.

B. Qualification Data: For qualified Installer and professional engineer.

C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Welding certificates.

E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.8 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Construction Manager no fewer than two (2) days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

1. Sprinkler system design shall be approved by authorities having jurisdiction.

a. Margin of Safety for Available Water Flow and Pressure: Twenty percent (20%), including losses through water-service piping, valves, and backflow preventers.
b. Sprinkler Occupancy Hazard Classifications:

1) Office and Public Areas: Light Hazard.
2) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.

2. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.

3. Maximum Protection Area per Sprinkler:

a. Office Spaces: 196 sq. ft.
b. Storage Areas: 130 sq. ft.
c. Mechanical Equipment Rooms: 130 sq. ft.
d. Electrical Equipment Rooms: 130 sq. ft.
e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

C. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Galvanized- and Black-Steel Pipe: ASTM A 53, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 40, Galvanized and Black-Steel Pipe: ASTM A 53; Schedule 40 in 2” and smaller.

C. Pipe in "Schedule 10, Black-Steel Pipe" Paragraph below is intended for use with flanged, roll-grooved, plain-end-pipe, and welded joints. Pipe is available in NPS 1/2 to NPS 10 (DN 15 to DN 250).

D. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2-1/2 to NPS 5; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

E. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, standard-weight, seamless steel pipe with threaded ends.

F. Galvanized- and Uncoated-Steel Couplings: ASTM A 865, threaded.

G. Galvanized and Uncoated, Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, Class 300, standard pattern.

H. Malleable- or Ductile-Iron Unions: UL 860.

I. Cast-Iron Flanges: ASME 16.1, Class 125.

J. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8-inch-thick, ASME B16.21, nonmetallic and asbestos free, or EPDM rubber gasket.

a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.

b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

K. Steel Welding Fittings: ASTM A 234 and ASME B16.9.

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

L. Grooved-Joint, Steel-Pipe Appurtenances:

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

a. Anvil International
b. Tyco Fire Products LP
c. Victaulic Company

2. Pressure Rating: 175-psig minimum.
3. Painted Grooved-End Fittings for Steel Piping: ASTM A 47, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

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

a. Anvil International
b. Tyco Fire Products LP
c. Victaulic Company

2. Standard: UL 213.
3. Pressure Rating: 175-psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flexible Sprinkler Hose Fittings:

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

a. FlexHead Industries, Inc.
b. Gateway Tubing, Inc.
c. Victaulic Company

2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175-psig minimum.
5. Size: Same as connected piping, for sprinkler.

2.4 SPRINKLERS

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

1. Reliable Automatic Sprinkler Co., Inc. (The)
2. Tyco Fire Products LP
3. Victaulic Company

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

D. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.

E. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal ½-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

F. Sprinkler Finishes: Match existing.

G. Special Coatings: Match existing.

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one-piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one-piece, flat.

I. Sprinkler Guards:

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

a. Reliable Automatic Sprinkler Co., Inc. (The)
b. Tyco Fire Products LP
c. Victaulic Company

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install sprinkler piping with drains for complete system drainage.

H. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

I. Fill sprinkler system piping with water.

J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

K. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. 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.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

B. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, charge systems 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. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.7 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, malleable-iron threaded fittings, threaded fittings; and threaded joints.
2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, malleable-iron threaded fittings, threaded fittings; and threaded joints.
3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, threaded fittings; and threaded joints.
2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, threaded fittings; and threaded joints.
3. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
5. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
6. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.

3.8 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

4. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211313

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

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

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

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Jay R. Smith Mfg. Co.
2. Zurn Industries, LLC

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company
4. Metraflex Company (The)
5. Proco Products, Inc.

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

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Plastic or stainless-steel.
3. Connecting Bolts and Nuts: Stainless-steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company
4. Metraflex Company (The)
5. Proco Products, Inc.

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

2.5 GROUT

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

B. Characteristics: Non-shrink; recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

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

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

C. Secure nailing flanges to concrete forms.

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

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

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

2. Exterior Concrete Walls below Grade:

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

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

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

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

3. Concrete Slabs-on-Grade:

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

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

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

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

4. Concrete Slabs above Grade:

a. Copper Piping: Molded PVC sleeves.
b. Ferrous Piping (All Sizes): Galvanized-steel-pipe sleeves.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for 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.
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.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
f. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Dial-type pressure gages.
2. Gage attachments.
3. Test plugs.
4. Test-plug kits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

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

a. Ametek U.S. Gauge
b. Ashcroft Inc.
c. Ernst Flow Industries
d. Flo Fab Inc.
e. Marsh Bellofram
f. Miljoco Corporation
g. Noshok
h. Palmer Wahl Instrumentation Group
i. REOTEMP Instrument Corporation
j. Tel-Tru Manufacturing Company
k. Trerice, H. O. Co.
l. Watts; a Watts Water Technologies company

m. Weiss Instruments, Inc.
n. Weksler Glass Thermometer Corp.
o. WIKA Instrument Corporation
p. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: Liquid-filled Sealed type(s); cast aluminum or drawn steel; 4½-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless-steel.
11. Accuracy: Grade A, plus or minus one percent (+/-1%) of middle half of scale range.

2.2 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.3 TEST PLUGS

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

1. Flow Design, Inc.
2. Miljoco Corporation
3. Nexus Valve, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts; a Watts Water Technologies company
8. Weiss Instruments, Inc.
9. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless-steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM self-sealing rubber.

2.4 TEST-PLUG KITS

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

1. Flow Design, Inc.
2. Miljoco Corporation
3. Nexus Valve, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts; a Watts Water Technologies company
8. Weiss Instruments, Inc.

B. Furnish one (1) test-plug kit containing thermometer(s), one (1) pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

B. Install valve and snubber in piping for each pressure gage for fluids.

C. Install test plugs in piping tees.

D. Install pressure gages on natural gas piping system.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be the following:

1. Liquid-filled Sealed Open-front, pressure-relief, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with EPDM self-sealing rubber inserts.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Gas Piping: 0 to 10 psi.

END OF SECTION 220519

SECTION 220529 - 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. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

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

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 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.

2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

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

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

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "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: Pre-galvanized 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 stainless-steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless-steel.

C. Copper Pipe Hangers:

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

A. Clevis-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless-steel.

B. Strap-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless-steel.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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

a. Allied Tube & Conduit; a part of Atkore International
b. B-line, an Eaton business
c. Flex-Strut Inc.
d. Thomas & Betts Corporation; A Member of the ABB Group
e. Unistrut; Part of Atkore International
f. Wesanco, Inc.

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

2.5 THERMAL-HANGER SHIELD INSERTS

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

1. Carpenter & Paterson, Inc.
2. Clement Support Services
3. ERICO International Corporation
4. National Pipe Hanger Corporation

5. PHS Industries, Inc.
6. Pipe Shields Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

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

C. Insulation-Insert Material for Hot Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig 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 beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, 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.

2.7 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. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless-steel.
3. Vertical Members: Two (2) or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One (1) or more; plastic.
3. Vertical Members: Two (2) or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. 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.

2.8 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.

2.9 EQUIPMENT SUPPORTS

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

2.10 MISCELLANEOUS MATERIALS

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

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

1. Properties: Non-staining, non-corrosive, and non-gaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

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

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

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

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

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

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

G. Fastener System Installation:

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

H. 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.

I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

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

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

L. 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.

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

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

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

P. 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.

Q. Insulated Piping:

1. Attach clamps and spacers to piping.

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

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

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

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

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

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

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048-inch-thick.
    b. NPS 4: 12 inches long and 0.06-inch-thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06-inch-thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075-inch-thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105-inch-thick.

5. Pipes NPS 8 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 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 1½ inches.

3.5 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.

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

3.6 HANGER AND SUPPORT SCHEDULE

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

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

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

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

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

F. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel attachments for hostile environment applications.

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

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

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

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two (2) rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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

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

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

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

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

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

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

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

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

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

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1¼ inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to twenty-five percent (25%) to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to twenty-five percent (25%) to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to twenty-five percent (25%) to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two (2) vertical-type supports and one trapeze member.

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

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

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

S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 221316 - 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. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than two (2) days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 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.
2. Waste, Force-Main Piping: 50 psig.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 VRF/COOLING COIL CONDENSATE DRAIN PIPING

A. If more than one (1) material is listed, material selection is Contractor's option.

B. Copper Tubing:

1. Drawn-Temper Tubing: According to ASTM B 88, Type L, ASTM B 88, Type M or Type DWV according to ASTM B 306.
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B 32, lead-free alloys, and water-flushable flux according to ASTM B813.

C. CPVC plastic pipe according to ASTM F 441, Schedule 40, with socket-type pipe fittings according to ASTM F 438 and solvent cement according to ASTM F 493.

D. PVC plastic pipe according to ASTM D 1785, Schedule 40, with socket-type pipe fittings according to ASTM D 2466 and solvent cement according to ASTM D 2564, primer according to ASTM F 656.

E. Pre-Insulated Pex Tube:

1. Source Limitations: Obtain PEX tube from single manufacturer.
2. Tube Material: PEX plastic in accordance with ASTM F 876 and ASTM F 877.
3. ½-Inch Microcellular Foam Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

F. Pre-Insulated Pex Tube Fittings – Domestic Water:

1. Source Limitations: Obtain PEX tube fittings from single manufacturer.
2. Fittings: ASTM F 1807, metal insert and copper crimp rings ASTM F 1960, cold expansion fittings and reinforcing rings.
3. Push-Fit Fittings: ASSE 1061, push-fit fittings.

4. ½-Inch Microcellular Foam Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

G. Drain size in accordance with the International Plumbing Code:

EQUIPMENT CAPACITY	MINIMUM CONDENSATE PIPE DIAMETER (inch)
Up to 20 tons of refrigeration	3/4 inch
Over 20 tons to 40 tons of refrigeration	1 inch
Over 40 tons to 90 tons of refrigeration	1 1/4 inches
Over 90 tons to 125 tons of refrigeration	1 1/2 inches
Over 125 tons to 250 tons of refrigeration	2 inches

For SI: 1 inch = 25.4 mm, 1 ton of capacity = 3.517 kW.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Unshielded, Non-pressure Transition Couplings:

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

      1) Dallas Specialty & Mfg. Co.
      2) Fernco Inc.
      3) Froet Industries LLC
      4) Mission Rubber Company, LLC; a division of MCP Industries
      5) Plastic Oddities

   b. Standard: ASTM C 1173.
   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
   d. End Connections: Same size as and compatible with pipes to be joined.
   e. Sleeve Materials:

      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

3. Shielded, Non-pressure Transition Couplings:

   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

      1) Cascade Waterworks Mfg. Co.
      2) Mission Rubber Company, LLC; a division of MCP Industries

   b. Standard: ASTM C 1460.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.

4. Pressure Transition Couplings:

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

1) Cascade Waterworks Mfg. Co.
2) Dresser, Inc.
3) EBAA Iron, Inc.
4) Ford Meter Box Company, Inc. (The)
5) Jay R. Smith Mfg. Co.
6) JCM Industries, Inc.
7) Romac Industries, Inc.
8) Viking Johnson

b. Standard: AWWA C219.
c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Manufacturer's standard.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep ¼ bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back-to-back or side by side with common drain pipe.

a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of waste piping in direction of flow is prohibited.

K. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent (2%) downward in direction of flow for piping NPS 3 and smaller; two percent (2%) downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: Two percent (2%) downward in direction of flow.
3. Vent Piping: One percent (1%) down toward vertical fixture vent or toward vent stack.

L. 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/A 21.5.

M. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

N. Install aboveground PVC piping according to ASTM D 2665.

O. Install force mains at elevations indicated.

P. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.

2. Install drains in sanitary waste gravity-flow piping.

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 INSTALLATION OF VRF/COOLING COIL SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.
2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

a. Details indicated on Drawings.
b. Manufacturer's requirements.
c. Governing codes.
d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than ¼-inch per foot.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    c. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Plastic, Non-Pressure-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. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Shielded, non-pressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

    a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
    b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
4. Vertical Piping: MSS Type 8 or Type 42, clamps.
5. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
7. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with ½-inch rod.
4. NPS 3 and NPS 5: 10 feet with ½-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with ¾-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with ½-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with ¾-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

H. Install supports for vertical PVC piping every 48 inches.

I. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.6 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 waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste 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 waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Equipment: Connect waste piping as indicated.

a. Provide shutoff valve if indicated and union for each connection.
b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 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 waste 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.

a. 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 waste and vent piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
c. 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.

    a. 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.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. 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.

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.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.

    a. Isolate test source and allow to stand for 4 hours.
    b. 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.

3.8 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping 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.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two (2) coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Refer to Schedules on Drawings.

END OF SECTION 221316

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.3 DEFINITIONS

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

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

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

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.
3. Minimum Operating Pressure of Service Meter: 5 psig.
4. Natural-Gas System Pressure from Street: 5 psi.
5. Natural-Gas System Pressures within Buildings: Two (2) pressure ranges. Primary pressure is 2 psi; secondary pressure is 0.25 psi (7” wc).

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

1.5 ACTION SUBMITTALS

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

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.

3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Service meters. Indicate pressure ratings and capacities. Include bypass fittings and meter bars.
6. Dielectric fittings.

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

1. Shop Drawing Scale: ¼-inch per foot.
2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

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

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

1.6 INFORMATIONAL SUBMITTALS

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

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

C. Qualification Data: For qualified professional engineer.

D. Welding certificates.

E. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

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

1.8 QUALITY ASSURANCE

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

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

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

1.9 DELIVERY, STORAGE, AND HANDLING

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

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

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

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

1.10 PROJECT CONDITIONS

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

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

1. Notify Architect, Construction Manager and Owner no fewer than two (2) days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without written permission.

1.11 COORDINATION

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

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

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

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

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

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
2. Operating-Pressure Rating: 0.5 psig.
3. End Fittings: Zinc-coated steel.
4. Threaded Ends: Comply with ASME B1.20.1.
5. Maximum Length: 72 inches

B. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

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

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

2.4 MANUAL GAS SHUTOFF VALVES

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

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

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1-inch and smaller.
6. Service Mark: Valves 1¼ inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

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

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

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

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

a. A.Y. McDonald Mfg. Co.
b. Apollo Valves; Conbraco Industries, Inc.
c. BrassCraft Manufacturing Co.; a Masco company
d. Lyall, R. W. & Company, Inc.

e. Perfection Corporation

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

E. Bronze Plug Valves: MSS SP-78.

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

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

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Non-lubricated Plug Valves: MSS SP-78.

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

a. A.Y. McDonald Mfg. Co.
b. Mueller Co.
c. Xomox Corporation

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:

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

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

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

a. Actaris
b. American Meter Company
c. Fisher Control Valves & Instruments; a brand of Emerson Process Management
d. Invensys
e. Itron Gas
f. Richards Industries

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

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

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

a. Actaris
b. American Meter Company
c. Eclipse Innovative Thermal Technologies
d. Fisher Control Valves & Instruments; a brand of Emerson Process Management
e. Invensys
f. Itron Gas
g. Maxitrol Company
h. Richards Industries

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.

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

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

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

    a. Canadian Meter Company Inc.
    b. Eaton
    c. Harper Wyman Co.
    d. Maxitrol Company
    e. SCP, Inc.

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

2.6 DIELECTRIC FITTINGS

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

B. Dielectric Unions:

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

    a. A.Y. McDonald Mfg. Co.
    b. Capitol Manufacturing Company
    c. Central Plastics Company
    d. HART Industrial Unions, LLC
    e. Jomar Valve
    f. Matco-Norca
    g. Watts; a Watts Water Technologies company
    h. Wilkins
    i. Zurn Industries, LLC

2. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig minimum at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

a. Capitol Manufacturing Company
b. Central Plastics Company
c. Matco-Norca
d. Watts; a Watts Water Technologies company
e. Wilkins

2. Description:

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

D. Dielectric-Flange Insulating Kits:

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

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company
d. Pipeline Seal and Insulator, Inc.

2. Description:

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

2.7 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

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

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

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

3.3 OUTDOOR PIPING INSTALLATION

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

B. Install pressure gage and shut off valve upstream and downstream from each regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping." Install dirt leg.

3.4 INDOOR PIPING INSTALLATION

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

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. 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.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of two percent (2%) down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of three (3) pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1½ inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.5 VALVE INSTALLATION

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

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

3.6 PIPING JOINT CONSTRUCTION

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

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

C. Threaded Joints:

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

D. Welded Joints:

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

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

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8-inch.

2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8-inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8-inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, ½-inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8-inch.

3.8 CONNECTIONS

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

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

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

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

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

3.9 PAINTING

A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.

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

1. Alkyd System: **MPI EXT 5.1D**.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel gloss.
d. Color: Yellow.

C. Paint exposed, interior metal piping, valves, service regulators, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: **MPI INT 5.1Q**.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex gloss.
d. Color: Yellow.

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

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 DEMONSTRATION

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

3.12 PIPING SCHEDULE

A. See Drawings for pipe schedule.

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

3.13 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground:

1. PE valves.
2. NPS 2 and Smaller: Bronze plug valves.
3. NPS 2-1/2 and Larger: Cast-iron, lubricated plug valves.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one (1) of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

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

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

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

1. Bronze plug valve.

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

1. Cast-iron, lubricated plug valve.

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

1. Bronze plug valve.

END OF SECTION 231123

SECTION 230000 – BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Basic Mechanical Requirements specifically applicable to Division 23 Sections in addition to Division 1 General Requirements.

1.2 INTENT

A. It is the intention of the Specifications and Drawings to call for finished work, tested and ready for operation. All materials, equipment, and apparatus shall be new and of first-class quality.

B. Any apparatus, appliance, material, or work not shown on Drawings, but mentioned in the Specifications, or vice versa, or any incidental accessories or minor details not shown, but necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be provided by the Contractor without additional expense to the Owner.

C. With submission of bid, the Contractor shall give notice to the Engineer of any materials apparatus or omissions believed to be in violation of laws, ordinances, rules or regulations, or authorities having jurisdiction. In the absence of such written notice, it is mutually agreed that the Contractor shall include the cost of providing all systems in accordance with applicable regulations without extra compensation.

1.3 SUBMITTALS

A. Submit under provisions of Division 01 Sections.

B. Include products as required by individual Sections.

C. Submit Shop Drawings and Product Data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

D. Mark dimensions and values in units to match those specified.

E. Submit plan indicating measures being taken to maintain indoor air quality of occupied portion of building during construction.

1.4 DRAWINGS AND COORDINATION

A. Drawings are schematic in nature and do not indicate every item, piece of equipment, and detail. Provide complete operating systems.

B. Install work as closely as possible to layouts shown on Drawings. Modify work as necessary to meet job conditions and to clear other equipment. Consult Architect before making changes which affect the function or appearance of systems.

C. Dimensions, elevations, and locations are shown approximately. Verify dimensions in field.

D. Architect reserves the right to order changes in layout of such items as piping, ducts, and equipment if such changes do not substantially effect costs and if effected items have not been fabricated or installed.

E. In some cases, Drawings are based on products of one (1) or several manufacturers, as listed on Contract Documents. Contractor shall be responsible for modifications made necessary by substitution of products of other manufacturers. Modifications may be required in electrical distribution materials and components, structural supports, concrete pads, gas piping, breeching and chimneys, etc.

F. Do not install part of a system until all critical components of the system and related systems have been approved. Coordinate parts of systems.

G. Coordinate work with work specified in other Sections. Relocate work if required for proper installation and functioning of other systems.

H. Install products in accordance with manufacturer's instructions. Notify Architect if Contract Documents conflict with manufacturer's instructions. Comply with Architect's interpretations.

I. Provide brackets, supports, anchors and frames required for installation of work specified in this division. Such metal work shall conform to the requirements of Section 055000 “Metal Fabrications”.

J. Where Contract Documents provide conflicting information, Contractor shall be responsible for design having highest cost.

1.5 PROJECT RECORD DRAWINGS

A. Prepare project Record Drawings of mechanical systems in conformance with the requirements of the General Conditions and Division 01 Sections.

1.6 INDOOR AIR QUALITY

A. Provide measures to maintain minimum standard for indoor air quality in accordance with SMACNA guidelines, by preventing air contaminated by demolition and construction activities from being transferred to occupied portions of building when work includes renovation, addition, or alteration to building occupied during demolition/construction.

B. Measures shall include but not be limited to the following:

1. Air filtration.
2. Temporarily sealing ductwork, air inlets and outlets and ventilation openings to prevent transfer of contaminated air.
3. Installation of bypass ducts or openings and additional temporary system modifications as required to prevent cross contamination, and to maintain proper system operation during construction.

C. Submit plan of cross contamination control measures in accordance with SMACNA guidelines prior to beginning construction.

1.7 PRELIMINARY OPERATION

A. Operate mechanical systems with required supervision for at least two (2) full days prior to substantial completion. Make necessary adjustments and check proper operation.

1.8 TESTS PRIOR TO SUBSTANTIAL COMPLETION

A. Tests shall be attended by representatives of mechanical subcontractors, equipped with instruments required to demonstrate proper functioning of systems, as specified. Demonstrate the following:

1. Equipment installed and operating in accordance with the manufacturer's specifications and instructions and with these specifications.
2. Safety and temperature controls operating as specified.
3. Systems properly flushed, cleaned and free of contaminants.
4. Systems properly balanced.
5. Motors equipped with proper overload protection and not operating under overload. Obtain ammeter readings.
6. Instruments recording properly.
7. Submit report listing system tested, date, results, and description of fault corrections, if any.

1.9 WARRANTY

A. Submit written warranty of warranties covering work specified in Division 23. Warranty period shall be one (1) year from the date of Substantial Completion of the building or of the equipment being warranted, whichever is later. Owner is to receive full use of equipment for period of warranty.

1.10 OPERATING AND MAINTENANCE MANUALS

A. Submit Operating and Maintenance manuals in accordance with this Section and Division 01 Sections.

B. Include operating and maintenance instructions for equipment where applicable.

C. List replacement parts and order procedure.

D. Include lubrication instructions and schedule, with types of lubricant to be used.

E. Instruct Owner's personnel in use of equipment specified in this Division.

1.11 REGULATORY REQUIREMENTS

A. Conform to applicable provisions of the Connecticut Basic Building Code which include the following:

1. 2018 Connecticut State Building Code
2. 2015 International Mechanical Code w/Connecticut Amendments
3. 2015 International Plumbing Code w/Connecticut Amendments
4. Amendments, alterations, deletions, and addition of certain provisions to the above as indicated in subsequently-issued Supplements.

B. New construction and renovation work will also conform to applicable provisions of Connecticut Public Health Code.

C. Indoor air quality during construction will be maintained in accordance with SMACNA IAQ Guidelines for Occupied Buildings under Construction.

D. New construction and renovation work will also conform to applicable provisions of the Connecticut Fire Safety Code which include the following:

1. Code for Safety to Life from Fire in Buildings, National Fire Protection Association, Inc., Standard 101 (NFPA 101), 2015 Edition.
2. Amendments, alterations, deletions, and addition of certain provisions to the above as indicated in the Connecticut Supplement.

E. Work of this project shall be barrier free and will conform to the Americans with Disabilities Act (ADA), ICC/ANSI 117.1, 2009 and Uniform Federal Accessibility Standards (UFAS).

F. New construction and renovation work will comply with the requirements of the 2015 International Energy Conservation Code for energy efficiency.

G. Obtain and pay for permits and inspections from authorities having jurisdiction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 230000

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

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

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

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

2.2 MOTOR CHARACTERISTICS

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

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

2.3 POLYPHASE MOTORS

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

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

C. Service Factor: 1.15.

D. Multi-speed Motors: Variable torque.

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

E. Multi-speed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

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

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

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

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

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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

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

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

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

2.5 SINGLE-PHASE MOTORS

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

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

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

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

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

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

PART 3 - EXECUTION (Not Used)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

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

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

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

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

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless-steel.
3. Connecting Bolts and Nuts: Stainless-steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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

2.5 GROUT

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

B. Characteristics: Non-shrink; recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

1. Sleeves are not required for core-drilled holes.

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

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

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

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

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

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

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

C. Secure nailing flanges to concrete forms.

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

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6: Sleeve-seal fittings.
b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves.

2. Exterior Concrete Walls below Grade:

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

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

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

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

3. Concrete Slabs-on-Grade:

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

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

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

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

4. Concrete Slabs above Grade:

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

5. Interior Partitions:

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

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated rough-brass finish.
f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Fastener systems.
5. Pipe stands.
6. Equipment supports.

B. Related Sections:

1. Section 055000 “Metal Fabrications”
2. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
3. Section 233113 “Metal Ducts”

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 HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

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

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

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

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

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

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "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: Pre-galvanized or hot dipped.
3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Copper Pipe Hangers:

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

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Unistrut Corporation or comparable product by one (1) of the following:

    a. Allied Tube & Conduit
    b. Cooper B-Line, Inc.
    c. Flex-Strut Inc.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation
    f. Wesanco, Inc.

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

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Unistrut Corporation or comparable product by one (1) of the following:

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

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

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide product by one (1) of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services
3. ERICO International Corporation
4. National Pipe Hanger Corporation
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig 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 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 beyond sheet metal shield for piping operating below ambient air temperature.

2.5 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 steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

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

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One (1) or more; plastic.
3. Vertical Members: Two (2) or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

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

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

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

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, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

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 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.

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

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

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

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

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 inches and larger and at changes in direction of piping.

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

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

N. Insulated Piping:

1. Attach clamps and spacers to piping.

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

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2 12 inches long and 0.048-inch-thick.
   b. NPS 4 (DN 100): 12 inches long and 0.06-inch-thick.

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

3.2 PIPE HANGERS AND SUPPORT SPACING

A. Support horizontal steel and copper as follows:

1. ½- to 1¼-Inch Pipe Size: 6’-0” maximum hanger spacing.
2. 1½- to 2-Inch Pipe Size: 10’-0” maximum hanger spacing.
3. 2½- to 3-Inch Pipe Size: 10’-0” maximum hanger spacing.
4. 4- to 6-Inch Pipe Size: 10’-0” maximum hanger spacing.

3.3 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.

3.4 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 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.

3.5 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 ½-inch beyond nut.

3.6 PAINTING

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

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

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

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

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

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

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

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

1. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
2. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
3. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
5. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

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

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

K. 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 piping installations.
2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
3. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

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

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one (1) of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

3. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

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

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1¼ inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to twenty-five percent (25%) to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to twenty-five percent (25%) to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to twenty-five percent (25%) to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two (2) vertical-type supports and one (1) trapeze member.

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

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

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

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS 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 the following:

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Restrained spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers with vertical-limit stops.
8. Pipe riser resilient supports.
9. Resilient pipe guides.
10. Restrained vibration isolation roof-curbs.
11. Seismic snubbers.
12. Restraining braces and cables.
13. Steel vibration isolation equipment bases.
14. Restrained isolation roof curb rails.

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. Provide wind and seismic restraints in accordance with the requirements of the Connecticut State Building Code.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.

    a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic and Wind-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.

C. 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.

D. Welding certificates.

1.6 INFORMATIONAL SUBMITTALS

A. 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.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control test reports.

1.7 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. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 ISOLATION PADS

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

1. Cambridge
2. Kinetics Noise Control
3. Mason Industries
4. Vibro-Acoustics

B. 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.

C. Size: Factory or field cut to match requirements of supported equipment.

1. Pad Material: Oil and water resistant with elastomeric properties.
2. Surface Pattern: Waffle pattern.
3. Infused nonwoven cotton or synthetic fibers.
4. Load-bearing metal plates adhered to pads.
5. Sandwich-Core Material: Resilient and elastomeric.

    a. Surface Pattern: Waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

6. Resilient Material: Oil- and water-resistant neoprene.

2.2 ELASTOMERIC ISOLATION MOUNTS (DOUBLE DEFLECTION)

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

1. Cambridge
2. Kinetics Noise Control
3. Mason Industries
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation
6. Vibro-Acoustics

B. Mounting Plates:

1. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
2. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

C. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

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

1. Cambridge
2. Kinetics Noise Control
3. Mason Industries
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation
6. Vibro-Acoustics

B. Description: All-directional isolator with restraints containing two (2) separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

1. Housing: Cast-ductile iron or welded steel.
2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED SPRING ISOLATORS

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

1. Cambridge
2. Kinetics Noise Control
3. Mason Industries
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation
6. Vibro-Acoustics

B. Description: 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 ¼-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and internal 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 eighty percent (80%) of the compressed height of the spring at rated load.
4. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
5. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
6. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.

2.5 HOUSED-RESTRAINED-SPRING ISOLATORS

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

1. Cambridge
2. Kinetics Noise Control
3. Mason Industries
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation
6. Vibro-Acoustics

B. Description:

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

2. Outside Spring Diameter: Not less than eighty percent (80%) of the compressed height of the spring at rated load.
3. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
4. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
5. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.

2.6 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two (2) steel tubes separated by a minimum of ½-inch-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 and for equal resistance in all directions.

2.7 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two (2) steel tubes or post and sleeve arrangement separated by a minimum of ½-inch-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.

2.8 SPRING HANGERS

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

1. Kinetics Noise Control
2. Mason Industries
3. Vibration Eliminator Co., Inc.
4. Vibration Isolation
5. Vibro-Acoustics

B. Description: 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 eighty percent (80%) of the compressed height of the spring at rated load.
3. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
4. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
5. Overload Capacity: Support two hundred percent (200%) 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. 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.

2.9 VIBRATION ISOLATION EQUIPMENT BASES

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

1. Cambridge
2. Kinetics Noise Control
3. Mason Industries
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation
6. Vibro-Acoustics

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

    a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36. Rails 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. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch 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. 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.

D. Concrete Inertia Base: 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 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. 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.
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.

2.10 RESTRAINED VIBRATION ISOLATION ROOF-CURBS

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

1. Mason Industries
2. Isolaton Technology, Inc.
3. Kinetics Noise Control
4. Thybar Corporation
5. Vibration Eliminator Co., Inc.
6. Vibration Isolation

B. General Requirements for Restrained Vibration Isolation Roof-Curb: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support equipment and to withstand seismic and wind forces.

C. Lower Support Assembly: Formed sheet-metal “Z” section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

D. The curb shall be built to seismically contain the roof top unit. The unit must be solidly fastened to the top floating rail and the lower section anchored to the roof structure.

E. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on ¼-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic and wind restraint.

a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.

b. Outside Spring Diameter: Not less than eighty percent (80%) of the compressed height of the spring at rated load.
c. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
d. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
e. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.

2. 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.

a. Resilient Material: Oil- and water-resistant natural rubber.

F. Snubber Bushings: All-directional, elastomeric snubber bushings at least ¼ inches thick.

G. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

H. Acoustic Barrier Package: The package shall consist of high transmission loss 2-inch-thick panel assembly. The panel shall be constructed of two (2) sheets of 16-gauge galvanized steel, filled with insulation, 2-inch-thick, 1.25 lbs/cu. ft. minimum density.

2.11 SEISMIC-RESTRAINT DEVICES

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

1. Cooper B-Line, Inc.; a division of Cooper Industries
2. Hilti, Inc.
3. Kinetics Noise Control
4. Loos & Co.; Cableware Division
5. Mason Industries
6. TOLCO Incorporated; a brand of NIBCO INC.
7. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four (4) times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum ¼-inch air gap, and minimum ¼-inch-thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building

structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A 603 galvanized steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two (2) clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times (8x) diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.12 FACTORY FINISHES

A. 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.

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. 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.

B. 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. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

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. 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 o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

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 VIBRATION ISOLATION AND SEISMIC RESTRAINT OF DUCTWORK

A. Vibration Isolation of Ductwork:

1. All discharge runs for a distance of 50 feet from the connected equipment shall be isolated from the building structure by means of specification 10 hangers or specification 5 floor isolators. Spring deflection shall be a minimum of 0.75-inch.
2. All duct runs having air velocity of 1000 fpm or more shall be isolated from the building structure by specification 11 hangers or 5 floor supports. Spring deflection shall be a minimum of 0.75-inch.

B. Seismic Restraint of Ductwork:

1. Restrain rectangular ducts with cross sectional area of 6 sq. ft. or larger.
2. Restrain round ducts with diameters of 28 inches or larger.
3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
4. Transverse restraints shall occur at 30-foot intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
5. Longitudinal restraints shall occur at 60-foot intervals with at least one (1) restraint per duct run. Transverse restraints for one (1) duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4 feet of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
6. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
7. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
8. Walls, including gypsum board nonbearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
9. Connection to the structure must be made with a non-friction connection.

C. Ductwork Exclusions:

1. Rectangular and square and ducts that are less than 6 square feet in cross sectional area.
2. All trapezed ductwork where the distance from the suspension point to the trapeze member is 12 inches or less.
3. Ductwork hung with straps where the top of the duct is 12 inches or less from the suspension point and the strap has two (2) #10 sheet metal screws within 2 inches of the top of the duct.
4. If any suspension location in the run exceeds the above, the entire run must be braced.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. 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 post connection testing has been approved), and with at least seven (7) days advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four (4) of each type and size of installed anchors and fasteners selected by Architect.
5. Test to ninety percent (90%) of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

C. Remove and replace malfunctioning units and retest as specified above.

D. 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 active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

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

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

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

D. Valve numbering scheme.

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

1.4 COORDINATION

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

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

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.
3. Minimum Letter Size: ¼-inch for name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets.

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

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8½-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: Multi-layer, multi-color, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.

B. Letter Color: Red.

C. Background Color: White.

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

E. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.

F. Minimum Letter Size: ¼-inch name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

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, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

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 1½ inches high.

2.4 DUCT LABELS

A. Material and Thickness: Multi-layer, multi-color, plastic labels for mechanical engraving, 1/16-inch-thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: White.

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

E. Minimum Label Size: Length and width vary for required label content, but not less than 2½-by-¾-inch.

F. Minimum Letter Size: ¼-inch for name of units if viewing distance is less than 24 inches, ½-inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

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

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

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1½ inches high.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with ¼-inch letters for piping system abbreviation and ½-inch numbers.

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

B. Valve Schedules: For each piping system, on 8½-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

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

2.6 WARNING TAGS

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

1. Size: 3 by 5¼ inches minimum.
2. Fasteners: Brass grommet and chain.

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.

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 10 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.3 DUCT LABEL INSTALLATION

A. Install plastic-laminated self-adhesive duct labels with permanent adhesive on air ducts.

B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1-inch-high is needed for proper identification because of distance from normal location of required identification.

C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 10 feet in each space where ducts are exposed or concealed by removable ceiling system.

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 HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

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

1. Valve-Tag Size and Shape:

    a. Refrigerant: 2 inches, round.
    b. Gas: 2 inches, round.

2. Valve-Tag Colors:

    a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
    b. Flammable Fluids: Black letters on a safety-yellow background.
    c. Combustible Fluids: White letters on a safety-brown background.
    d. Potable and Other Water: White letters on a safety-green background.
    e. Compressed Air: White letters on a safety-blue background.
    f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Testing, Adjusting, and Balancing of Air Systems:

   a. Constant-volume air systems.
   b. Variable-air-volume systems.
   c. Multi-zone systems.

2. Testing, adjusting, and balancing of equipment.
3. Sound tests.
4. Vibration tests.
5. Duct leakage tests verification.
6. Pipe leakage tests verification.
7. UFAD plenum leakage tests verification.
8. HVAC-control system verification.

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 independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

G. UFAD: Underfloor air distribution.

1.4 PRE-INSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of fourteen (14) days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

   a. The Contract Documents examination report.
   b. The TAB plan.

c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

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

B. Contract Documents Examination Report: Within thirty (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 thirty (30) days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within thirty (30) days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. 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.

1.6 QUALITY ASSURANCE

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

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

B. TAB Conference: Meet with Owner, Engineer, and Construction Manager on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven (7) 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.

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

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

G. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

H. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

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

1.8 COORDINATION

A. Notice: Provide seven (7) days' advance notice for each test. Include scheduled test dates and times.

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, engage one (1) of the following:

1. Advanced Testing & Balancing – Stanley Ward – (203) 931-0316
2. Air Balancing Service Co. – Michael Mauro – (203) 234-8222
3. Environmental Testing & Balancing, Inc. – (203) 234-2089
4. James E. Brennan Co, Inc – (203) 269-1454
5. Technical Associates Group, Inc – Douglas McKay – (203) 294-1820
6. Wing’s Testing & Balancing – (203) 481-4988

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

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

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

E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan 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.

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

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

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

J. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.

K. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

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

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

N. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

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 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

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

B. Cut insulation, ducts, pipes, and equipment casings 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 Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 2307 "HVAC Insulation”.

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

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

3.5 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Fans and ventilators.
3. Terminal units.
4. Dedicated outdoor-air units.
5. Variable-refrigerant-flow systems.

6. Heat pumps.
7. Fan coil units.

3.6 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' Record drawings 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.

3.7 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. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. 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 occurs. 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.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.

b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
d. Adjust controls so that terminal is calling for minimum airflow.
e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust the system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

6. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

a. Balance the return-air ducts and inlets.
b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:

a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
b. Re-measure and confirm that total airflow is within design.
c. Re-measure final fan operating data, speed, volts, amps, and static profile.
d. Mark final settings.
e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
f. Verify tracking between supply and return fans.

3.9 PROCEDURES FOR MULTIZONE SYSTEMS

A. Position the unit's automatic zone dampers for maximum flow through the cooling coil.

B. The procedures for multi-zone systems will utilize the zone balancing dampers to achieve the indicated airflow within the zone.

C. After balancing, place the unit's automatic zone dampers for maximum heating flow. Retest zone airflows and record any variances.

D. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air and relief-air dampers for proper position that simulates minimum outdoor air conditions.
    b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. 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 occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

E. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

F. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlet and outlet airflow.
3. Adjust each inlet and outlet for specified airflow.

4. Re-measure each inlet and outlet after they have been adjusted.

G. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.10 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. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.11 PROCEDURES FOR AIR-COOLED HEAT PUMP UNITS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record entering and leaving refrigerant pressures.

D. Measure and record operating data of compressor(s), fan(s), and motors.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each coil:

1. Entering- and leaving temperature.
2. Dry-bulb temperature of entering and leaving air.
3. Wet-bulb temperature of entering and leaving air for cooling coils.
4. Airflow.
5. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Air pressure drop.

5. Voltage and amperage input of each phase at full load.
6. Calculated kilowatt at full load.
7. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

3.13 SOUND TESTS

A. After systems are balanced and Substantial Completion, measure and record sound levels at ten (10) locations as designated by the Architect.

B. Instrumentation:

1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels and measuring the equivalent continuous sound pressure level (L_{eq}).
3. The sound-testing meter must be capable of using one-third octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
4. The accuracy of the sound-testing meter shall be plus or minus 1 decibel.

C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.
4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
5. Record a set of background measurements in dBA and sound pressure levels in the eight (8) unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight (8) unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:

a. Location.
b. System tested.
c. dBA reading.
d. Sound pressure level in each octave band with equipment on and off.

2. Plot sound pressure levels on Noise Criteria (NC) worksheet with equipment on and off.

3.14 VIBRATION TESTS

A. After systems are balanced and Substantially Completion, measure and record vibration levels on equipment having motor horsepower equal to or greater than 10.

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:

1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.
5. Read each bearing on motor, fan as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from AABC's "National Standards for Total System Balance." Acceptable levels of vibration are normally "smooth" to "good."
4. Include in General Machinery Vibration Severity Chart, with conditions plotted.

3.15 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.16 PIPE LEAKAGE TESTS

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.17 UFAD PLENUM LEAKAGE TESTS

A. Witness the UFAD plenum pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.18 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify HVAC control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.19 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.

6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates by more than five percent (5%), make equipment adjustments to achieve the calculated rates. If increase or decrease is five percent (5%) or less, equipment adjustments are not required.
4. Balance each air outlet.

3.20 TOLERANCES

A. Set HVAC system's airflow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus ten percent (+/-10%). If design value is less than 100 cfm, within 10 cfm.
2. Air Outlets and Inlets: Plus or minus ten percent (+/-10%). If design value is less than 100 cfm, within 10 cfm.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.21 PROGRESS 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 system-balancing devices. Recommend changes and additions to system-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.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturers' test data.

3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
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 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. Heating coil, dry-bulb conditions.
    e. Face and bypass damper settings at coils.
    f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    g. Variable-frequency controller settings for variable-air-volume systems.
    h. Settings for pressure controller(s).
    i. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Pipe and valve sizes and locations.
4. Terminal units.
5. Balancing stations.
6. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.

c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Inlet and discharge static pressure in inches wg.
e. For each filter bank, filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
j. Outdoor airflow in cfm.
k. Return airflow in cfm.
l. Outdoor-air damper position.
m. Return-air 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 o.c.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.

c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Refrigerant expansion valve and refrigerant types.
i. Refrigerant suction pressure in psig.
j. Refrigerant suction temperature in deg F.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and speed.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

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

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.

e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft.
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

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

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

J. 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 fan and air-handling-unit number.
b. Location and zone.

c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

L. System-Coil Reports: For reheat coils and 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. Airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.

M. 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 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Architect and Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either ten percent (10%) of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. 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."

D. If the number of "FAILED" measurements is greater than ten percent (10%) of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall 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. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.24 ADDITIONAL TESTS

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

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

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Calcium silicate.
b. Cellular glass.
c. Flexible elastomeric.
d. Mineral fiber.

2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Lagging adhesives.
7. Sealants.
8. Factory-applied jackets.
9. Field-applied fabric-reinforcing mesh.
10. Field-applied cloths.
11. Field-applied jackets.
12. Tapes.
13. Securements.
14. Corner angles.

B. Related Sections:

1. Section 233113 "Metal Ducts" for duct liners.

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. Qualification Data: For qualified Installer.

C. 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.

D. 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 Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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

C. Coordinate installation and testing of heat tracing.

1.7 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 one (1) of the following:

   a. Industrial Insulation Group (The); **Thermo-12 Gold**

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. 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.
4. 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. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

   a. Cell-U-Foam Corporation; **Ultra-CUF**
   b. Pittsburgh Corning Corporation; **Foamglas Super K**

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

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

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

   a. Aeroflex USA Inc.; **Aerocel**
   b. Armacell LLC; **AP Armaflex**
   c. RBX Corporation; **Insul-Sheet 1800** and **Insul-Tube 180**

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

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

    a. CertainTeed Corp.; **Duct Wrap**
    b. Johns Manville; **Microlite**
    c. Knauf Insulation; **Duct Wrap**
    d. Manson Insulation Inc.; **Alley Wrap**
    e. Owens Corning; **All-Service Duct Wrap**

J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

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

    a. Johns Manville; **HTB 23 Spin-Glas**
    b. Owens Corning; **High Temperature Flexible Batt Insulations**

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

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

    a. CertainTeed Corp.; **Commercial Board**
    b. Johns Manville; **800 Series Spin-Glas**
    c. Knauf Insulation; **Insulation Board**
    d. Owens Corning; **Fiberglas 700 Series**

L. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

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

    a. Johns Manville; **1000 Series Spin-Glas**
    b. Owens Corning; **High Temperature Industrial Board Insulations**
    c. Roxul Inc.; **Roxul RW**
    d. Thermafiber; **Thermafiber Industrial Felt**

M. Mineral-Fiber, Preformed Pipe Insulation:

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

    a. Johns Manville; **Micro-Lok**
    b. Knauf Insulation; **1000 Pipe Insulation**
    c. Manson Insulation Inc.; **Alley-K**
    d. Owens Corning; **Fiberglas Pipe Insulation**

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

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

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

a. Knauf Insulation; **Permawick Pipe Insulation**
b. Owens Corning; **VaporWick Pipe Insulation**

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

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

a. CertainTeed Corp.; **CrimpWrap**
b. Johns Manville; **MicroFlex**
c. Knauf Insulation; **Pipe and Tank Insulation**
d. Manson Insulation Inc.; **AK Flex**
e. Owens Corning; **Fiberglas Pipe and Tank Insulation**

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 1 or 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

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

a. Johns Manville; **Super Firetemp M**

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 1 or 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

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

a. CertainTeed Corp.; **FlameChek**
b. Johns Manville; **Firetemp Wrap**
c. 3M; **Fire Barrier Wrap Products**

2.3 INSULATING CEMENTS

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

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

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

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

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

a. P. K. Insulation Mfg. Co., Inc.; **Thermal-V-Kote**

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

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

a. Insulco, Division of MFS, Inc.; **SmoothKote**
b. P. K. Insulation Mfg. Co., Inc.; **PK No. 127** and **Quik-Cote**
c. Rock Wool Manufacturing Company; **Delta One Shot**

2.4 ADHESIVES

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

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Products: Subject to compliance with requirements, provide one (1) 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**
d. Mon-Eco Industries, Inc.; **22-30**
e. Vimasco Corporation; **760**

C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

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

a. Childers Products, Division of ITW; **CP-96**
b. Foster Products Corporation, H. B. Fuller Company; **81-33**

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

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

a. Aeroflex USA Inc.; **Aeroseal**
b. Armacell LCC; **520 Adhesive**
c. Foster Products Corporation, H. B. Fuller Company; **85-75**

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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

a. Childers Products, Division of ITW; **CP-82**
b. Foster Products Corporation, H. B. Fuller Company; **85-20**

c. Marathon Industries, Inc.; **225**

F. 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 (1) of the following:

a. Childers Products, Division of ITW; **CP-82**
b. Foster Products Corporation, H. B. Fuller Company; **85-20**
c. Marathon Industries, Inc.; **225**

G. PVC Jacket Adhesive: Compatible with PVC jacket.

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

a. Dow Chemical Company (The); **739, Dow Silicone**
b. Johns-Manville; **Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive**
c. Red Devil, Inc.; **Celulon Ultra Clear**

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

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 (1) of the following:

a. Childers Products, Division of ITW; **CP-35**
b. Foster Products Corporation, H. B. Fuller Company; **30-90**
c. Marathon Industries, Inc.; **590**

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, fifty-nine percent (59%) by volume and seventy-one percent (71%) by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

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

a. Childers Products, Division of ITW; **CP-10**
b. Foster Products Corporation, H. B. Fuller Company; **35-00**
c. Marathon Industries, Inc.; **550**

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: Sixty-three percent (63%) by volume and seventy-three percent (73%) by weight.
5. Color: White.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one (1) 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**

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.7 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Products, Division of ITW; **CP-76**
b. Foster Products Corporation, H. B. Fuller Company; **30-45**
c. Marathon Industries, Inc.; **405**
d. Pittsburgh Corning Corporation; **Pittseal 444**

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one (1) 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**

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide 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.

5. Color: White.

2.8 FACTORY-APPLIED JACKETS

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

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

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

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

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

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

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

7. 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 one (1) of the following:

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

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.9 FIELD-APPLIED FABRIC-REINFORCING MESH

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

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

a. Vimasco Corporation; **Elastafab 894**

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

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

a. Childers Products, Division of ITW; **Chil-Glas No. 5**

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

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

a. Foster Products Corporation, H. B. Fuller Company; **Mast-A-Fab**
b. Vimasco Corporation; **Elastafab 894**

2.10 FIELD-APPLIED CLOTHS

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

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

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

2.11 FIELD-APPLIED JACKETS

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

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

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one (1) 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.

D. Metal Jacket:

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

    a. Childers Products, Division of ITW; **Metal Jacketing Systems**
    b. PABCO Metals Corporation; **Surefit**
    c. RPR Products, Inc.; **Insul-Mate**

2. Aluminum Jacket: Comply with ASTM B 209, 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-thick, heat-bonded polyethylene and Kraft paper.
    d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and Kraft paper.
    e. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240.

    a. Sheet and roll stock ready for shop or field sizing.
    b. Material, finish, and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and Kraft paper.
    d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and Kraft paper.
    e. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: 125-mil-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, provide one (1) of the following:

a. Pittsburgh Corning Corporation; **Pittwrap**
b. Polyguard; **Insulrap No Torch 125**

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

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

a. Polyguard; **Alumaguard 60**

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

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

a. Dow Chemical Company (The), **Saran 540 Vapor Retarder Film**

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

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

a. Dow Chemical Company (The), **Saran 560 Vapor Retarder Film**

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

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

a. Dow Chemical Company (The); **Saran 540 Vapor Retarder Film** and **Saran 560 Vapor Retarder Film**

2.12 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 (1) 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.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: Two percent (2%).
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one (1) 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.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: Two percent (2%).
6. Tensile Strength: 40 lbf/inch 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 (1) 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.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: Five hundred percent (500%).
6. Tensile Strength: 18 lbf/inch in width.

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

1. Products: Subject to compliance with requirements, provide one (1) 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.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: Five percent (5%).
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

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

   a. Dow Chemical Company (The); **Saran 540 Vapor Retarder Tape**

2. Width: 3 inches.

3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: One hundred forty-five percent (145%).
6. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

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

a. Dow Chemical Company (The); **Saran 560 Vapor Retarder Tape**

2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: One hundred forty-five percent (145%).
6. Tensile Strength: 55 lbf/inch in width.

2.13 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one (1) 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, Type 304 or Type 316; 0.015-inch-thick, ¾-inch-wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, ¾-inch 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-diameter shank, length to suit depth of insulation indicated.

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

1) AGM Industries, Inc.; **CWP-1**
2) GEMCO; **CD**
3) Midwest Fasteners, Inc.; **CD**
4) Nelson Stud Welding; **TPA**, **TPC**, and **TPS**

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1½-inch galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, provide one (1) 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 (1) 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-thick by 2 inches square.
   c. Spindle: Stainless-steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. 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 (1) of the following:

      1) GEMCO; **Nylon Hangers**
      2) Midwest Fasteners, Inc.; **Nylon Insulation Hangers**

   b. Baseplate: Perforated, nylon sheet, 0.030-inch-thick by 1½ inches in diameter.
   c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2½ inches.
   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 (1) 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-thick by 2 inches square.

c. Spindle: Stainless steel, fully annealed, 0.106-inch-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-thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1½ inches in diameter.

a. Products: Subject to compliance with requirements, provide one (1) 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-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1½ inches in diameter.

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

1) GEMCO
2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal ¾-inch- wide, stainless-steel or Monel.

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

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

a. C & F Wire
b. Childers Products
c. PABCO Metals Corporation
d. RPR Products, Inc.

2.14 CORNER ANGLES

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

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

C. Stainless-Steel Corner Angles: 0.024-inch-thick, minimum 1-by-1-inch, stainless-steel according to ASTM A 167 or ASTM A 240, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless-Steel: Coat 300 series stainless-steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

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

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

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

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

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1½ inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than seventy-five percent (75%) of its nominal thickness.

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

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

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

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

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

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

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

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

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "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 one hundred percent (100%) coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not 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 (1) circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two (2) circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation 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 one hundred percent (100%) coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040-inch-thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

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

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two (2) times the thickness of pipe insulation, or one (1) 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 (2) times the thickness of pipe insulation, or one (1) 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 (2) times the thickness of pipe insulation, or one (1) 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 (2) 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 (2) halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two (2) 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 Boiler Breechings and Ducts:

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

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch 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. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

C. 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.

D. 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.

E. 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 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

3.10 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1-inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for one hundred percent (100%) coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one (1) edge and one (1) end of insulation segment. Secure laps to adjacent insulation section with ½-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for one hundred percent (100%) coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one (1) edge and one (1) end of insulation segment. Secure laps to adjacent insulation section with ½-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and

inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.11 FIELD-APPLIED JACKET INSTALLATION

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

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

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

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1½-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

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

1. Apply two (2) continuous beads of adhesive to seams and joints, one (1) bead under lap and the finish bead along seam and joint edge.

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

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

1. Apply three (3) separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-pre-sized jackets around individual pipe insulation sections with one (1) end overlapping the previously installed sheet. Install pre-sized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1¼ 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 33½ inches or less. The 33½-inch-circumference limit allows for 2-inch overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one (1) 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 1¼ circumferences to avoid damage to tape edges.

3.12 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Firestop systems are specified in Section 078413 "Penetration Firestopping."

3.13 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two (2) 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 (2) coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect and Owner from manufacturer’s entire range. Vary first and second coats to allow visual inspection of the completed Work.

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

3.14 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

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

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

3.15 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.16 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Refer to Schedule on Drawings.

3.17 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Refer to Schedule on Drawings.

3.18 EQUIPMENT INSULATION SCHEDULE

A. Refer to Schedule on Drawings.

3.19 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 (1) material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.20 INDOOR PIPING INSULATION SCHEDULE

A. Refer to Schedule on Drawings.

3.21 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refer to Schedule on Drawings.

3.22 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Refer to Schedule on Drawings.

3.23 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Refer to Schedule on Drawings.

3.24 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Refer to Schedule on Drawings.

3.25 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

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

END OF SECTION 230700

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM 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. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration, and installation for complete building automation system (also identified as BMS, Direct Digital Control System For HVAC) including all necessary hardware and all operating and applications software as required for the complete performance of the Work, as shown on the Drawings, as specified herein.

B. Related Sections:

1. Section 230993 “Sequence of Operations for HVAC Controls”

C. Network level components of the system – workstations, servers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2004. No gateways shall be used for communication to controllers furnished under this section.

D. At a minimum, provide controls for the following:

1. Rooftop units.
2. Boilers including hot water pumps.
3. Cabinet unit heater controls.
4. Computer room air handling units.
5. Exhaust and supply fans.
6. Finned tube radiation control.
7. Monitoring points for packaged equipment such as emergency generators.
8. Power wiring to DDC devices, smoke control dampers, and BAS panels except as otherwise specified.
9. Return air fans.
10. Variable volume and constant volume box control including interlocks with finned tube radiation.
11. Variable frequency drives.

E. Except as otherwise noted, the control system shall consist of all necessary ethernet network controllers, standalone digital control units, room controllers, workstations, software, sensors, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.

F. The BAS system supplier shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.

G. All interlocking wiring, wiring, and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS system supplier and representatives of the Owner will review and check out the system – see System Acceptance and Testing section of this document. At that time, the BAS system supplier shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

H. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor, and Owner's representative.

I. All work performed under this section of the specifications will comply with all governing codes, laws, and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.3 REFERENCES

A. General, Code Compliance: The codes listed below form a part of this Specification to the extent referenced. The codes are referred to in the text by the basic designation only. The edition/revision of the referenced code shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

1. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
2. All equipment or piping used in conditioned air streams, spaces, or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
3. All wiring shall conform to the National Electrical Code.
4. All smoke dampers shall be rated in accordance with UL 555S.
5. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
6. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.4 DEFINITIONS

A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

1. Standard:

a. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers.
b. AHU: Air Handling Unit.
c. BACnet: Building Automation Controls Network.
d. BMS: Building Management System.
e. DDC: Direct Digital Control.
f. EIA: Electronic Industries Alliance.
g. GUI: Graphical User Interface.
h. HVAC: Heating, Ventilation, and Air Conditioning.
i. IEEE: Institute Electrical Electronic Engineers.
j. MER: Mechanical Equipment Room.
k. PID: Proportional, Integral, Derivative.
l. VAV: Variable Air Volume Box.

2. Communications and Protocols:

    a. ARP: Address Resolution Protocol.
    b. BACnet: Building Automation and Control Networks.
    c. CORBA: Common Object Request Broker Architecture.
    d. CSMA/CD: Carrier Sense Multiple Access/Collision Detect.
    e. DDE: Dynamic Data Exchange.
    f. FTP: File Transfer Protocol.
    g. FTT: Free Topology Transceivers.
    h. HTTP: Hyper Text Transfer Protocol.
    i. IIOP: Internet Inter-ORB Protocol.
    j. IP: Internet Protocol.
    k. LAN: Local Area Network.
    l. LON: Echelon Communication – Local Operating Network.
    m. MS/TP: Master Slave Token Passing.
    n. OBIX: Open Building Information Exchange.
    o. ODBC: Open Database Connectivity.
    p. ORB: Object Request Broker.
    q. SNVT: Standard Network Variables Types.
    r. SQL: Structured Query Language.
    s. UDP: User Datagram Protocol.
    t. XML: eXtensible Markup Language.

3. Controllers:

    a. ASD: Application Specific Device.
    b. AAC: Advanced Application Controller.
    c. ASC: Application Specific Controller.
    d. CAC: Custom Application Controller.
    e. DCU: Distributed Control Unit.
    f. HRC: Hotel Room Controller.
    g. LCM: Local Control Module.
    h. MC: MicroControllers.
    i. MPC: Multi-purpose Controller.
    j. NSC: Network Server Controller.
    k. PEM: Package Equipment Module.
    l. PPC: Programmable Process Controller.
    m. RC: Room Controller.
    n. RPC: Room Purpose Controller.
    o. SDCU: Standalone Digital Control Units.
    p. SLC: Supervisory Logic Controller.
    q. UEC: Unitary Equipment Controller.
    r. VAVDDC: Variable Air Volume Direct Digital Controller.

4. Tools and Software:

    a. AFDD: Automated Fault Detection and Diagnostic.
    b. APEO: Automated Predictive Energy Optimization.
    c. DR: Demand Response.
    d. CCDT: Configuration, Commissioning and Diagnostic Tool.
    e. BPES: BACnet Portable Engineering Station.
    f. LPES: LON Portable Engineering Station.
    g. POT: Portable Operator’s Terminal.
    h. PEMS: Power and Energy Management Software.
    i. MTBF: Mean Time Between Failure.

1.5 SYSTEM DESCRIPTION

A. In accordance with the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The Contractor must provide PC-based programming workstations, operator workstations, and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.

B. All new BMS control points and controllers shall be integrated into the existing Schneider Electric Ecostruxure BMS System at Middlebrook School.

C. For this project, the system shall consist of the following components:

1. Administration and Programming Workstation(s): The BAS system supplier shall include Operation software and architecture as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third-party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.
2. Web-Based Operator Workstations: The BAS system supplier shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer-based hardware to support the web-based user interface.
3. Ethernet-based Network Router and/or Network Server Controller(s): The BAS system supplier shall furnish the needed quantity of Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
4. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).

D. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, Modbus, XML, and HTTPS for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.

E. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

F. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as a common communication protocol between controllers and integral

ANSI/ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as an MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI/ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

G. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering, and card access should easily coexist on the same network channel.

1. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
2. Data shall reside on a supplier-installed server for all database access.
3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network.

H. All work described in this section shall be installed, wired, circuit tested, and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of five (5) years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration, and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in-place support facility within one hundred (100) miles of the site with factory certified technicians and engineers, spare parts inventory, and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, seven (7) days/week emergency service available.

1.6 SUBMITTALS

A. General: Submittals shall be in accordance with the requirements of Section 013300 “Submittals” and Division 23, in addition to those specified herein.

1. All shop drawings shall be prepared in Visio Professional or AutoCAD software. In addition to the drawings, the Contractor shall furnish a CD containing the identical information. Drawings shall be B size or larger.
2. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typicals will be allowed where appropriate.
3. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper, and air flow station schedules shall indicate size, configuration, capacity, and location of all equipment.
4. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms, and configuration to be furnished with the workstation software. Information shall be bound or in a three-ring binder with an index and tabs. Diagrams shall be on 11-by-17-inch foldouts. If color has been used to differentiate information, the printed copies shall be in color.

5. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor, prior to submitting, shall check all documents for accuracy.
6. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
7. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as “As-Built”.

    a. System architecture drawing.
    b. Layout drawing for each control panel.
    c. Wiring diagram for individual components.
    d. System flow diagram for each controlled system.
    e. Instrumentation list for each controlled system.
    f. Sequence of control.
    g. Binding map.
    h. A matrix sheet detailing all system addresses and communication settings for the following:

        1) All IP network addresses and settings.
        2) All BMS device addresses and communication settings.

    i. Operation and maintenance manuals.

8. Information common to the entire system shall be provided. This shall include but not be limited to the following:

    a. Product manuals for the key software tasks.
    b. Operating the system.
    c. Administrating the system.
    d. Engineering the operator workstation.
    e. Application programming.
    f. Engineering the network.
    g. Setting up the web server.
    h. Report creation.
    i. Graphics creation.
    j. All other engineering tasks.
    k. System Architecture Diagram.
    l. List of recommended maintenance tasks associated with the system servers, operator workstations, data servers, web servers and web clients.
    m. Define the task.
    n. Recommend a frequency for the task.
    o. Reference the product manual that includes instructions on executing the task.
    p. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
    q. Licenses, guarantees, and warranty documents for equipment and systems.
    r. Submit one (1) copy for each building, plus two (2) extra copies.

9. Information common to the systems in a single building shall be provided.

    a. System architecture diagram for components within the building annotated with specific location information.
    b. As-built drawing for each control panel.
    c. As-built wiring design diagram for all components.
    d. Installation design details for each I/O device.

e. As-built system flow diagram for each system.
f. Sequence of control for each system.
g. Binding map for the building.
h. Product data sheet for each component.
i. Installation data sheet for each component.
j. Submit two (2) copies for each building and two (2) extra copies.

10. Software shall be provided:

a. Submit a copy of all software installed on the servers and workstations.
b. Submit all licensing information for all software installed on the servers and workstations.
c. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
d. Submit all licensing information for all the software used to execute the project.
e. All software revisions shall be as installed at the time of the system acceptance.
f. Firmware Files.
g. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
h. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
i. Submit a copy of all application files that were created during the execution of the project.
j. Submit a copy of all graphic page files created during the execution of the project.

1.7 QUALITY ASSURANCE

A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of three (3) years.

1. The Building Management System contractor shall have a full-service facility within one hundred (100) miles of the project that is staffed with engineers trained and certified by the manufacturer in the configuration, programming, and service of the automation system. The contractor’s technicians shall be fully capable of providing instructions and routine emergency maintenance service on all system components.
2. Any installing contractor, not listed as prequalified in the Approved Manufacturer's section, shall submit credentials as detailed in the Pre-bid Submittal section for the engineer’s review two (2) weeks prior to bid date. Failure to follow the attached formats shall disqualify potential alternate bidders. Credentials must attest that the Contractor meets all requirements of the specification and the Engineers judgment regarding approval to bid as an acceptable installer after reviewing the data will be final.

B. All bidders must be authorized distributors or branch offices of the manufacturers specified.

C. The following bidders have been pre-qualified:

1. Schneider Electric Ecostruxure by Environmental Systems Corporation (ESC) – Contact Rich Burr at 860-221-4331

D. Any installing contractors or manufacturers interested in participating as acceptable bidders for this project that are not pre-qualified shall furnish a detailed technical pre-bid submittal to the consulting engineer.

1. All information must be submitted 2 weeks prior to the published bid date to allow the engineer adequate time to review the bidder’s credentials.

2. System Integrator Qualifications:

    a. The HVAC Control System shall be furnished, engineered, and installed by a licensed Controls Contractor or System Integrator (SI) for a minimum of ten (10) years. All work provided under this section shall be provided by direct employees of the SI or under the direct supervision of the SI personnel.
    b. The system integrator must be an authorized factory direct representative in good standing of the manufacturer of the proposed hardware and software components. Provide a letter dated within the last six (6) months, from the manufacture certifying that the System Integrator is an authorized factory direct representative.
    c. The SI shall have an office within fifty (50) miles of the Building site that is staffed with a minimum of ten (10) certified technicians who have successfully completed the factory authorized training of the proposed manufactures hardware and software components and have successfully completed a Niagara 4 certification course. supplying complete maintenance. SI must provide proof of required training. The SI capabilities shall include engineering and design of control systems, programming, electrical installation of control systems, troubling shooting, and service. **SI shall be staffed to provide support services on a 24 hour, 7-day-a-week basis**.
    d. The SI shall submit a list of no less than three (3) similar projects, which have similar Building Automation Systems as specified herein installed by the SI. These projects must be on-line and functional such that the Owner's/User's representative can observe the system in full operation.

E. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the Owner indicating that the installed system functions in accordance with the plans and specifications.

F. The BAS system supplier shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water, and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. If the vendor is providing an AFDD/CC system, use of the analytics shall be used to help commission the system.

G. The BAS system supplier shall provide a technician labor required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS system supplier shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

H. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data such as voltages, offsets, or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.

I. Required elements of the startup testing include:

1. Measurement of voltage sources, primary and secondary.
2. Verification of proper controller power wiring.
3. Verification of component inventory when compared to the submittals.
4. Verification of labeling on components and wiring.
5. Verification of connection integrity and quality (loose strands and tight connections).
6. Verification of bus topology, grounding of shields and installation of termination devices.
7. Verification of point checkout.

8. Each I/O device is landed per the submittals and functions per the sequence of control.
9. Analog sensors are properly scaled and a value is reported
10. Binary sensors have the correct normal position and the state is correctly reported.
11. Analog outputs have the correct normal position and move full stroke when so commanded.
12. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
13. Documentation of analog sensor calibration (measured value, reported value, and calculated offset).
14. Documentation of Loop tuning (sample rate, gain, and integral time constant).

J. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following.

1. Graphics navigation.
2. Trend data collection and presentation.
3. Alarm handling, acknowledgement, and routing.
4. Time schedule editing.
5. Application parameter adjustment.
6. Manual control.
7. Report execution.
8. Automatic backups.
9. Web Client access.

K. A Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion.

1.8 COORDINATION

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

B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.

C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

D. Coordinate with the Owner's IT department on locations for NSC's, Ethernet communication cabling and TCP/IP addresses.

1.9 OWNERSHIP

A. The Owner shall retain licenses to software for this project.

B. The Owner shall sign a copy of the manufacturer’s standard software and firmware licensing agreement as a condition of this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer’s license agreement but shall protect the manufacturer’s rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement shall not preclude the use of the software by individuals under contract to the Owner for commissioning, servicing, or altering the system in the future. Use of the software by individuals under contract to the Owner shall be restricted to use on the Owner’s

computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files, and documentation shall become the property of the Owner. These include but are not limited to:

1. Server and workstation software.
2. Application programming tools.
3. Configuration tools.
4. Network diagnostic tools.
5. Addressing tools.
6. Application files.
7. Configuration files.
8. Graphic files.
9. Report files.
10. Graphic symbol libraries.
11. All documentation.

1.10 WORK BY OTHERS

A. The BAS system supplier shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

B. The BAS system supplier shall furnish all Control Valves, Flow Meters, and Sensor Wells for installation by the Mechanical Contractor and/or others.

C. The BAS system supplier shall provide field supervision to the designated contractor for the installation of the following:

1. Automatic control dampers.
2. Blank-off plates for dampers that are smaller than duct size.
3. Sheet metal baffles plates to eliminate stratification.
4. The Electrical Contractor shall provide:

a. All 120VAC power wiring to motors, heat trace, and junction boxes for power to BAS panels.
b. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS system supplier to hardwire to fan shut down.

D. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer-stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.

E. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.

F. Inspect and report any concealed damage or violation of delivery, storage, and handling requirements to the Engineer.

1.11 WARRANTY

A. All components, system software, and parts furnished and installed by the BMS system supplier shall be guaranteed against defects in materials and workmanship for one (1) year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS system supplier at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS system supplier shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the Owner's request for warranty service within 24 standard working hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one (1) of the following pre-qualified manufacturers:

1. Electric/Electronic Components:

a. ACI
b. Belimo
c. Schneider-Electric Field Devices
d. Veris

2.2 OPEN, INTEROPERABLE SYSTEM ARCHITECTURE

A. General:

1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting, and information management for the entire facility, and Wide Area Network (WAN) if applicable.
2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
3. The Enterprise Level BAS shall support built-in reporting functionality without dependency on other software.
4. The Enterprise Level BAS shall support standard accessing of data for third party reporting or analytics software.
5. The Enterprise Level BAS shall be able to host up to two hundred fifty (250) servers, or NSCs, beneath it.
6. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows SQL based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
7. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, LonWorks IP, and/or Modbus TCP protocol.

B. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, LonTalk FTT-10A, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three (3) protocols to be natively supported.

C. A sub-network of SDCUs using the BACnet IP, BACnet MS/TP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

D. The TCP/IP layer connects all the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

E. The fieldbus layer shall support all the following types of SDCUs:

1. BACnet IP SDCU Requirements: The system shall consist of one (1) or more BACnet/IP field buses managed by the Network Server Controller. The field bus layer shall consist of up to fifty (50) IP SDCUs in daisy chain topology, or thirty-nine (39) if using RSTP, per layer, with a max of five (5) sub networks in daisy chain for a total of two hundred fifty (250) SDCUs or six (6) sub networks in RSTP for a total of two hundred thirty-four (234) SDCUs.
2. BACnet MS/TP SDCU Requirements: The system shall consist of one (1) or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to one hundred twenty-seven (127) Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2004. The NSCs shall be capable of at least two (2) BACnet MS/TP field buses for a total capability of two hundred fifty-four (254) SDCUs per NSC.

F. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

G. All NSCs, Workstation(s), and Servers shall be capable of residing directly on the Owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches, and hubs.

1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
2. Web-based operation shall be supported directly by the NSCs and require no additional software.
3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.
4. The system shall be able to operate normally and without restriction at multiple software version levels with the only requirement that each element of the hierarchy be at least as new a version as the newest version in the level below it. In other words, Enterprise Servers will be able to manage NSCs of different version provided that the Enterprise Server was the same or more recent version than the most recent NSC version.

H. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks FTT-10, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.3 OPERATOR WORKSTATION REQUIREMENTS

A. General:

1. The operator workstation portion of the BAS shall consist of one (1) or more full-powered configuration and programming workstations, and one (1) or more web-based operator workstations. For this project provide a minimum of ten (10) concurrent operator users and/or two (2) concurrent engineering users within the enterprise server.
2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
3. Web-based workstations (webstations) shall have a minimum of ten (10) concurrent operator users.
4. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, and trend charting. It shall be user-configurable for all data collection and data presentation functions.
5. A minimum of one (1) physical Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one (1) workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. General Administration and Programming Workstation Software:

1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
3. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

C. User Interface:

1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of “hot spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.
2. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.

3. The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Italian, Finnish, Portuguese, Swedish, Russian, and traditional and simplified Chinese. The multiple languages shall not require additional add on software from the standard workstation installer and shall be selectable within said workstation.
4. Webstations shall have the capability to automatically re-direct to an HTTPS connection to ensure more secure communications.
5. Personalized layouts and panels within workstations shall be extended to webstations to ensure consistent user experiences between the two (2) user interfaces.
6. Webstations shall give the user the same capabilities within the graphics pages as are given within the workstation but shall be mobile responsive for use on smaller devices.
7. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.
8. Workstation shall indicate at all times the communication status between it and the server.
9. The BMS web interface shall enable presentation mode whereby any functionality for interactivity shall be disabled.
10. The BMS web interface shall automatically detect light mode and dark mode settings in the operating system and adapt accordingly.
11. The BMS web interface shall allow override of the operating system's light/dark mode settings so that the setting can be enabled independent of the operating system's setting.
12. The BMS web interface shall automatically respond and adapt to different screen sizes and orientations from smart phone to smart televisions of any size.
13. The BMS web interface shall support slideshow functionality.
14. The BMS web interface shall support full screen mode displaying Alarm views/graphics/dashboards/Custom Reports.

D. User Access and Permissions:

1. The BMS system shall allow for the creation of one (1) account per user.
2. The BMS shall support Groups where User Accounts associated with the group can inherit group permissions.
3. The BMS shall be able to specify each user account/group accessibility to each object in the system.
4. The BMS permission system shall be possible to integrate with Windows Active directory.
5. The BMS shall be able to report on the permission level across account/group for review/archiving/audit.
6. This username/password combination shall be linked to a set of capabilities within the software, set and editable only by user with system administrator privileges. The sets of capabilities shall include: edit or View only, Acknowledge alarms, Enable/disable Program, and change values.
7. The system shall allow the above capabilities to be applied independently to each and every class of object in the system.
8. The BMS shall support integration with Windows Active Directory for user log on credentials.
9. The BMS shall support configurable reminder for "Days until password expires".
10. The BMS shall support configurable password policy across:

    a. Minimum number of characters
    b. Minimum number of lowercase characters
    c. Minimum number of numeric characters
    d. Minimum number of special characters
    e. Number of consecutive unique passwords before reuse
    f. No more than three repeating identical characters

11. The BMS user account management shall support password policy with the following components:

    a. Mandatory change of password at first logon with default credentials.
    b. Disabling of all imported user accounts by default.
    c. Custom password complexity rules and its enforcement.
    d. Custom password reuse and its enforcement.
    e. Configurable blacklisting of passwords to limit the use of commonly known passwords (e.g. password).
    f. Password aging rules.

12. The BMS shall be capable of enabling anonymous access (guest account) to previously engineered views such as dashboards, graphics, etc. with configurable permissions and without username or password.
13. It shall be possible to configure the BMS system so that the guest account is used by default to simplify presentation of Kiosk Mode across multiple screens.
14. The BMS shall provide time configurability to logout the user and to revert to a preconfigured presentation view, such as offered by the Guest account functionality.
15. The BMS shall provide configurability in managing access and permission levels based on location, IP addresses and address ranges, Schedule and Time of day and combination thereof.

E. System Security:

1. The BMS system supplier shall be certified to Security Development Lifecycle process that is certified to IEC 62443-4-1 by a reputable third-party independent lab.
2. The BMS system supplier shall be subjected to regular and verifiable best practice cyber security testing by the system supplier. Results of this testing shall be made available upon request prior to deployment of the system.
3. The BMS system supplier shall provide cyber security service incident escalation through help desk on a 7/24/365 basis.
4. The BMS shall support configuration for inactivity auto log-off of logged clients.
5. The BMS system shall support Self-Signed Certificates, Default Certificates, and/or Certification Authority (CA) certificates.
6. The BMS client communications (web access or rich client access) shall support TLS 1.2 encryption or higher.
7. The BMS shall allow configuration in disabling all devices and software that support HTTP and require access via HTTPS.
8. The BMS must be able to Alarm or generate notification on failed access attempts.
9. The BMS Servers shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks.
10. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
11. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.
12. The BMS shall have the capability to use blacklisted and whitelisted IPs/MAC addresses to gate access.
13. The BMS shall have the capability to differentiate, limit, or enable user access depending on Client's IP address/range (where) and time of day (when) the user is accessing the system.

F. Configuration Interface:

1. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report,

schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy-to-understand structure. All object names shall be alphanumeric and use Windows long filename conventions.

2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created from the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all “child” objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all the child objects with the change.

G. Color Graphic Displays:

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
2. Requirements of the color graphic subsystem include:

    a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
    b. The system shall support HTML5 enabled graphics.
    c. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
    d. The editor shall use Scalable Vector Graphics (SVG) technology.
    e. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, and graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
    f. Support for high DPI icons shall be included and automatically chosen if viewing on a high-definition display such as Retina or 4K displays.
    g. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
    h. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one (1) display to another.
    i. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one (1) graphic to another by selecting an object with a mouse - no menus will be required.
    j. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
    k. Graphics should rescale based on whatever monitor or viewing device is being used.
    l. Be able to create graphics on varying layers that can be moved and repeated.
    m. Be able to create graphics within varying windowpanes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.

n. The ability to create re-usable cascading menus.
o. The ability to have multiple instances of a graphic and edit one (1) instance to change all.

3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:

a. Create and save pages.
b. Group and ungroup symbols.
c. Modify an existing symbol.
d. Modify an existing graphic page.
e. Rotate and mirror a symbol.
f. Place a symbol on a page.
g. Place analog dynamic data in decimal format on a page.
h. Place binary dynamic data using state descriptors on a page.
i. Create motion through the use of animated .gif files or JavaScript.
j. Place test mode indication on a page.
k. Place manual mode indication on a page.
l. Place links using a fixed symbol or flyover on a page.
m. Links to other graphics.
n. Links to web sites.
o. Links to notes.
p. Links to time schedules.
q. Links to any .exe file on the operator workstation.
r. Links to .doc files.
s. Assign a background color.
t. Assign a foreground color.
u. Place alarm indicators on a page.
v. Change symbol/text/value color as a function of an analog variable.
w. Change a symbol/text/value color as a function of a binary state.
x. Change symbol/text/value as a function of a binary state.
y. All symbols used by Schneider Electric EcoBuilding Business in the creation of graphic pages shall be saved to a library file for use by the Owner.

H. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user configurable.

I. Alarm Management:

1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
2. Alarm management features shall include:

a. A minimum of one thousand (1000) alarm notification levels at the NSC, workstation, and web station levels.
b. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
c. At the Enterprise level the minimum number of active and viewable alarms shall be ten thousand (10,000).
d. It shall be possible for the user to sort, filter, and search on any available criteria such as priority, category, origin, alarm type, etc.

e. An active alarm viewer shall be included which can be customized for each user or user type to a hide or display any alarm attributes.
f. It shall be possible to present alarms with configurable colors based on priority, category, origin, alarm type, etc.
g. It shall be possible to link files/documents/hyperlinks/navigation links/graphics link to an alarm for easy access upon occurrence.
h. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username, and time of alarm silence (soft acknowledgement).
i. Alarm notifications must support multiple distribution methods within one (1) notification.
j. On alarm, it shall be possible to notify via email to a preconfigured list of recipients through a Simple Mail Transfer Protocol (SMTP) or secure email using Simple Mail Transfer Protocol Secure (SMTPS). No special software interfaces shall be required, and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.
k. On alarm, it shall be possible to notify via SNMP.
l. On alarm, it shall be possible to notify via file (on disk) that would be consumable by other alarm management services.
m. An operator shall have the capability to assign an alarm to another user of the system.
n. Individual alarms shall be able to be assigned to a user automatically via a preconfigured list of users and date/time. For example, a critical high temp alarm can be configured to be assigned to a Facilities Dept or to a Central Alarming workstation depending on time/date.
o. Playing an audible sound on alarm initiation or return to normal.
p. It shall be possible to assign a custom audio sound to each alarm/alarm-criteria (priority, category, origin, alarm type, etc.)
q. The active alarm viewer can be configured such that an operator must confirm that all the steps in a check list have been accomplished prior to acknowledging the alarm.
r. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to ‘normal’ and the quantity of disabled and hidden alarms.
s. The alarm viewer can be configured to auto hide alarms when triggered.
t. An operator shall have the capability to save and apply alarm favorites.
u. Alarms shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
v. Alarms shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
w. It shall be possible to configure user-actions via user/group permissions when responding to an alarm.
x. All operator actions responding to an alarm must be audit trailed.

J. Static Paginated Reporting/Custom Reporting:

1. The BMS Software and Network Servers shall support built-in native reporting capability without dependency on any external software.
2. It shall be possible to generate custom reports manually, via Schedule, Alarm triggered or custom conditions (e.g. program/schedule/etc.).
3. Custom Reporting shall have no dependency on external database.
4. Custom Reporting shall have the capability of reporting on the full range of available data, most recent to historical data.
5. It shall be possible to generate reports containing current active alarms.

6. The Building Management System software shall natively be capable of producing custom reports in .txt, .xlxs, and .pdf file formats.
7. The Custom Report capability at the BMS software shall support digital signing of pdf for traceability and authenticity.

K. Scheduling:

1. From the workstation or web station, it shall be possible to configure and download schedules for any of the controllers on the network.
2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
3. Schedules shall be programmable for a minimum of one (1) year in advance.
4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
5. Additionally, from the operator web stations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one (1) month to the next and view or alter any of the schedule times.
6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
9. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one (1) screen.
10. It should accommodate a minimum of sixteen (16) priority levels.
11. Values should be able to be controlled directly from a schedule, without the need for special program logic.
12. The workstation software shall have an application to save and restore NSC and field controller memory files.
13. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

L. Audit Trail:

1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last five thousand (5000) records of all events for the entire system from Workstation.
3. The Enterprise server shall be able to store up to five million (5,000,000) events.
4. The event view shall support viewing of up to one hundred thousand (100,000) events.
5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
6. It shall be capable to search and view all forced values within the system.

M. Web-based Operator Software:

1. General:

a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
c. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.

2. Graphic Displays:

a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
b. Through the browser-based interface, operators must be able to navigate through the entire system and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
c. System shall have out-of-the-box dashboards that enable customizable views of live data which can be public to all users or capable to make them specific to a user based on log in credentials.
d. The user shall have the ability to create custom dashboards.
e. The dashboards shall have a kiosk mode which allows for occupant level data display on monitors or tablets throughout the building.

3. Alarm Management:

a. Systems requiring additional client software to be installed on a PC for viewing the web station from that PC will not be considered.
b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

N. Groups and Schedules:

1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

O. User Accounts and Audit Trail:

1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

P. Web Services:

1. The installed system shall be able to use web services to “consume” information within the Network Server/Controllers (NSCs) with other products and systems. Inability to perform web services within the NSCs will be unacceptable.

    a. Shall be able to “consume” data into the system via SOAP and REST web services.

2.4 NETWORK SERVER CONTROLLERS (NSC)

A. Network Server Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

B. The BACnet NSC shall be classified as a “native” BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).

C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices and provide global supervisory control functions over the control devices connected to the NRS.

D. The NSCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices.

E. Whitelisting of file extensions for documents shall be capable.

F. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.2.

G. The NSCs shall support Simple Network Management Protocol version 3 (SNMPv3) for monitoring of the NSCs using a Network Management Tool.

H. The NSCs shall support remote system logging for used by System Information and Event Monitoring (SIEM) software.

I. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.

J. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

K. It shall be capable of executing application control programs to provide:

1. Calendar functions.
2. Scheduling.
3. Trending – System must be capable of storing trends for a period of one (1) year or greater.
4. Alarm monitoring and routing.
5. Time synchronization by means of an Internet site including automatic synchronization.
6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data.
7. Network Management functions for all LonWorks based devices.

L. Hardware Specifications:

1. Memory:

a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of twenty percent (20%) additional free memory.

2. Each NRC shall provide the following on-board hardware for communication:

a. Two (2) 10/100b Ethernet for communication to Workstations, other NRCs, IP field bus controllers, other SDCUs, and onto the internet.

1) The two (2) Ethernet ports shall support active switch and BACnet/IP communication protocols.
2) Support IPv4 addressing.
3) Ethernet port 1 shall support static or DHCP client configuration for communication to Workstation or other NSCs.
4) Ethernet port 2 shall support switch mode or DHCP server to set addressing of DHCP client devices.
5) It shall be possible to disable Ethernet port 2.
6) In DHCP server mode, the Ethernet port 2 shall support 50 BACnet/IP field controllers in daisy chain configuration directly from the port.
7) Each NSC shall be able to support a total of two hundred fifty (25)0 IP SDCUs in daisy chain configuration (five (5) sub networks via switch).
8) If using RSTP (Rapid Spanning Tree Protocol) with a managed switch (with IEEE 802.1W or IEEE 802.1Q-2014 support), Ethernet port 2 shall support up to thirty-nine (39) devices.
9) Each NSC shall be able to support a total of two hundred thirty-four (234) IP SDCUs in RSTP configuration (six (6) sub networks via managed switch).
10) Where a switch is needed, use a Cisco 9000 Catalyst or IE switch, EtherWAN EX63402-01B, or other equal and approved equivalent.

b. Two (2) RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable).
c. One (1) TP/FT port for communication to LonWorks devices.
d. One (1) device USB port.
e. One (1) host USB port.

3. The NSC shall conform to a small footprint no larger than 3.94W x 4.92H x 2.95D in.

M. Modular Expandability:

1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
2. One (1) shall be able to “hot-change” (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic.
3. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

N. Hardware Override Switches:

1. All digital outputs shall, optionally, include three-position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition, each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3-position manual override switch is placed in the ON position.

O. Universal Input Temperatures:

1. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.

   a. 10 kohm Type I (Continuum).
   b. 10 kohm Type II (I/NET).
   c. 10 kohm Type III (Satchwell).
   d. 10 kohm Type IV (FD).
   e. Linearized 10 kohm Type V (FD w/11k shunt).
   f. Linearized 10 kohm (Satchwell).
   g. 1.8 kohm (Xenta).
   h. 1 kohm (Balco).
   i. 20 kohm (Honeywell).
   j. 2.2 kohm (Johnson).

2. In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.

   a. PT100 (Siemens).
   b. PT1000 (Sauter).
   c. Ni1000 (Danfoss).

P. Local Status Indicator Lamps:

1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

Q. Real Time Clock (RTC):

1. Each NSC shall include a real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.
2. The RTC date and time shall also be accurate, up to ten (10) days, when the NSC is powerless.
3. No batteries may be used to for the backup of the RTC.

R. Power Supply:

1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one (1) power supply if heavily power consuming modules are required.
2. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

S. Automatic Restart After Power Failure:

1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

T. Data Retention:

1. During a power failure, the NSC shall retain all programs, configuration data, historical data, and all other data that is configured to be retained. There shall be no time restriction for this retention, and it must not use batteries to achieve it.

U. Software Specifications:

1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have full access to all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

V. User Programming Language:

1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
2. Network Server Controllers that use a “canned” program method will not be accepted.

W. Control Software:

1. The NSC shall have the ability to perform the following pre-tested control algorithms:

    a. Proportional, Integral plus Derivative Control (PID).
    b. Two-Position Control.
    c. Digital Filter.
    d. Ratio Calculator.
    e. Equipment Cycling Protection.

X. Mathematical Functions:

1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five (5) parentheses deep.

Y. NSCs shall have the ability to perform any or all the following energy management routines:

1. Time of Day Scheduling.
2. Calendar Based Scheduling.
3. Holiday Scheduling.
4. Temporary Schedule Overrides.
5. Optimal Start.
6. Optimal Stop.
7. Night Setback Control.
8. Enthalpy Switchover (Economizer).
9. Peak Demand Limiting.
10. Temperature Compensated Duty Cycling.
11. CFM Tracking.
12. Heating/Cooling Interlock.
13. Hot/Cold Deck Reset.
14. Hot Water Reset.
15. Chilled Water Reset.
16. Condenser Water Reset.
17. Chiller Sequencing.

Z. History Logging:

1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value, or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of one thousand (1000) logs, with a minimum of one hundred thousand (100,000) records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. For extended trend logging a minimum of fifteen hundred (1500) trends shall be capable, with a minimum number of six hundred thousand (600,000) records within.
3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
4. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least five hundred (500) trend samples before replacing the oldest sample with new data.
5. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales, and time spans.
6. Tooltips shall be present, magnetic, and visible based on users preference.
7. Comments shall be visible whenever viewing the trend log list.
8. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.
9. The BMS software and Network Servers shall support recording of all historical data, independent of any limitation in its local memory, which will be readily available for reporting and analysis without additional configurations or actions.
10. All historical data shall be available for use by the operator to access in BMS or a third-party reporting systems.

AA. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one (1) or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point.
3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Web station.
5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

BB. Embedded Web Server:

1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.
2. The NSC shall be configurable to logging all Embedded Web Server access attempts.
3. The NSC shall have the option to redirect HTTP-based Embedded Web Server connections to secure HTTPS connections.
4. The NSC shall authenticate and authorize all users connecting to the Embedded Web Server
5. The NSC shall provide the ability to configure an automatic logoff for Embedded Web Server users that have not had any activity for an adjustable time period.

CC. The NSC controller shall comply with the following regulatory certifications:

1. CE – EN 61000-6-3
2. CE – EN 61000-6-2
3. CE – EN 61010-1
4. CE – EN 61326-1
5. FCC CFR 47 Part 15 Class A
6. RCM
7. RoHS 2011/65/EU
8. China RoHS SJ/T 11364-2014
9. UL916 Energy Management equipment

2.5 BACNET IP FIELDBUS CONTROLLERS

A. Controllers – BACnet/IP Protocol:

1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC).
2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:

a. All controllers shall be able to communicate peer-to-peer without the need for an NSC.
b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:

1. Supporting IPv4 addressing.
2. Supporting Static IP setting, DHCP client and Auto-IP address acquisition.
3. It shall be possible to disable Ethernet port 2.

C. Topologies:

1. BACnet/IP Fieldbus controllers shall support daisy chain topology of up to fifty (50) controllers. In case of any disruption to communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
2. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to thirty-nine (39) controllers are supported.

a. In case of any disruption there shall be no communication interruption.
b. In case of any disruption there shall be system alarms that will inform the operator of the disruption.

D. Performance:

1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

E. Programmability:

1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.
2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs.
3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps.
5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO_2 and/or presence detector that does not utilize any of the I/O points of the controller.
6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs.
7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding output).

8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:

    a. Control processes.
    b. Energy management applications.
    c. Alarm management.
    d. Historical/trend data.
    e. Maintenance support applications.
    f. Custom processes.
    g. Manal override monitoring.

9. Each BACnet/IP Fieldbus controller shall support local trend data up to two (2) times the built-in I/O and at a minimum be capable of holding five (5) days at 15 min. intervals locally.
10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16-bit A/D converter.
11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10-bit D/A converter.
12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:

    a. At minimum eight (8) and up to twenty (20) configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.

        1) Universal Inputs – the following thermistors for use in the system without any external converters needed.

            a) 10 kohm Type I (Continuum).
            b) 10 kohm Type II (I/NET).
            c) 10 kohm Type III (Satchwell).
            d) 10 kohm Type IV (FD).
            e) Linearized 10 kohm Type V (FD w/11k shunt).
            f) Linearized 10 kohm (Satchwell).
            g) 1.8 kohm (Xenta).
            h) 1 kohm (Balco).
            i) 20 kohm (Honeywell).
            j) 2.2 kohm (Johnson).
            k) PT100 (Siemens).
            l) PT1000 (Sauter).
            m) Ni1000 (Danfoss).

        2) Analog Inputs:

            a) Current Input - 0-20 mA.
            b) Voltage Input 0-10 Vdc.

        3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
        4) Digital outputs.
        5) Analog outputs of 4-20 mA and/or 0-10 Vdc.

13. Real Time Clock (RTC):

    a. Provide internal clocks for all BACnet Controllers (B-AAC) using BACnet time synchronization services.

1) Automatically synchronize system clocks daily from an operator-designated controller.
2) The system shall automatically adjust for daylight saving time.

b. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.
c. The RTC shall provide the following: time of day, day, month, year, and day of week.
d. The RTC date and time shall also be accurate up to seven (7) days, from when the BACnet/IP Fieldbus controller has lost power with no reliance on.

14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications:

a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in 'flow thru' differential pressure transducer.
b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of plus or minus five percent (±5%) at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., ensuring primary air flow conditions shall be controlled and maintained to within plus or minus five percent (±5%) of setpoint at the specified minimum and maximum air flow parameters.
c. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing.
d. The BACnet/IP Fieldbus controller for VAV applications shall require no programing for air balancing algorithm.
e. All balancing parameters shall be synchronized in NSC.

15. Each BACnet/IP Fieldbus controller shall have a minimum of ten percent (10%) spare capacity for each point type represented on the controller for future point connection.
16. Power Requirements. 24VDC (21 to 33 VDC) and 24 VAC plus or minus twenty percent (+/-20%) with local transformer power.
17. Each BACnet/IP Fieldbus controller shall be accredited for smoke control and smoke management within a fully IP control solution.
18. The BACnet/IP Fieldbus controller shall comply with the following regulatory certifications:

a. CE - EMCD 2014/30/EU
b. CE LVD 2014/35/EU
c. FCC CFR 47 Part 15 Class B
d. RCM
e. RoHS 2011/65/EU
f. China RoHS SJ/T 11364-2014
g. UL2043 (Plenum space mounting)
h. UL916 Open-Energy Management equipment
i. UL916 Energy Management equipment

19. Intelligent Space Sensor Interface:

a. The BACnet/IP Fieldbus controllers shall support a dedicated RJ45 communication port to communicate and power up to four (4) intelligent wall mount sensors without the use of on-board inputs or outputs.
b. It shall be possible to disable the RJ45 communication port.

20. The BACnet/IP Fieldbus controller for Connected Room solutions.

a. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v14 or later) as specified BACnet Advanced Application Controller (B-AAC)

b. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:

1) All controllers shall be able to communicate peer-to-peer without the need for an NSC.
2) Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

c. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:

1) Supporting IPv4 addressing.
2) Supporting Static IP setting, DHCP client and Auto-IP address acquisition.
3) It shall be possible to disable Ethernet port 2.
4) Each BACnet/IP controller shall be configurable to restrict communications to only whitelisted IP addresses.

d. Topologies:

1) BACnet/IP Fieldbus controllers shall support daisy chain topology of up to fifty (50) controllers. In case of any disruption to communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
2) BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to thirty-nine (39) controllers are supported.

a) In case of any disruption there shall be no communication interruption.
b) In case of any disruption there shall be system alarms that will inform the operator of the disruption.

e. Performance:

1) Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2012 and the BACnet Device Profile supported.
2) They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.
3) Each BACnet/IP Fieldbus Controllers shall support upgrade of its firmware with no impact to its operation.

f. Programmability:

1) The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.
2) The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs.
3) All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

4) The BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps.
5) The BACnet/IP Fieldbus controllers shall support two (2) RS485 communication ports for connecting and supplying power to a range of protocol types:

a) BACnet/IP Fieldbus controllers shall support configurable selection of the supported protocol on the RS485 communications ports.
b) BACnet/IP Fieldbus controllers shall support a communications capability for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO_2 and/or presence detector that does not utilize any of the I/O points of the controller.
c) BACnet/IP Fieldbus controllers shall support a communications capability for connecting and supplying power to a matching connected module for the purpose of control of lights and blinds that do not utilize any of the I/O points of the controller.
d) BACnet/IP Fieldbus controllers shall support a communications capability for connecting to open market Modbus devices.

g. BACnet/IP Fieldbus controllers shall support on-board Bluetooth Low Energy radio to support:

1) Mobile application shall be available for controller commissioning.
2) Mobile applications shall be available for building occupants.
3) It shall be possible to disable the Bluetooth Low Energy Radio.
4) The BACnet/IP Fieldbus controller shall support a connection for an external antenna.

h. BACnet/IP Fieldbus controllers shall support an optional plug-in Zigbee 3.0 radio for the purpose of connecting to wireless Zigbee sensors and devices.

1) It shall be possible to connect to up to sixteen (16) Zigbee sensors or devices.
2) The controller shall support a range of different sensors and devices for easy commissioning.
3) The controller shall be able to connect to a Green Power Zigbee temperature and humidity sensor with ten (10) years of battery life.
4) The controller shall be able to connect to a Zigbee temperature, humidity, and CO_2 sensor with ten (10) years of battery life.

i. Controllers that only support older versions of the Zigbee 3.0 are not approved due to the lack of security layer.
j. It shall be possible to connect the Zigbee radio directly to the BACnet/IP RP Fieldbus controller.
k. It shall be possible to install the Zigbee radio in the ceiling using a purpose designed extension cable and ceiling housing when radio reception at the controller may be compromised.
l. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:

1) Control processes.
2) Energy management applications.
3) Alarm management.
4) Historical/trend data.
5) Maintenance support applications.

6) Custom processes.

m. In the case of communication disruption between the BACnet/IP Fieldbus controller and NSC/BMS, each BACnet/IP Fieldbus controller shall support storage of local trend data up to two (2) times the number of its built-in I/O at the collection rate of 5 min for five (5) days.

n. The BACnet/IP Fieldbus controller analog or universal input shall use a 16-bit A/D converter.

o. The BACnet/IP Fieldbus controller analog or universal output shall use a 10-bit D/A converter.

p. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:

1) Up to eight (8) configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.

a) Universal Inputs – the following thermistors for use in the system without any external converters needed.
b) 10K Ohm Type I (Continuum).
c) 10K Ohm Type II (I/NET).
d) 10K Ohm Type III (Satchwell).
e) 10K Ohm Type IV (FD).
f) Linearized 10K Ohm Type V (FD w/11k shunt).
g) Linearized 10K Ohm (Satchwell).
h) 1.8K Ohm (Xenta).
i) 1K Ohm (Balco).
j) 20K Ohm (Honeywell).
k) 2.2K Ohm (Johnson).
l) PT100 (Siemens).
m) PT1000 (Sauter).
n) Ni1000 (Danfoss).
o) Voltage Input – 0-10 Vdc.
p) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
q) Digital outputs.
r) Analog outputs 0-10 Vdc.

q. Internal Clock:

1) Provide internal clocks for all BACnet Controllers (B-AAC) using BACnet time synchronization services.

a) Automatically synchronize system clocks daily from an operator-designated controller.
b) The system shall automatically adjust for daylight saving time.

2) Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.
3) The RTC shall provide the following: time of day, day, month, year, and day of week.
4) The RTC date and time shall also be accurate up to seven (7) days, from when the BACnet/IP Fieldbus controller has lost power with no reliance on batteries.

r. Each BACnet/IP Fieldbus controller shall have a minimum of ten percent (10%) spare capacity for each point type represented on the controller for future point connection.
s. Power Requirements. 24VDC (21 to 33 VDC) and 24 VAC plus or minus twenty percent (+/-20%) with local transformer power.
t. Power Requirements. A line voltage version shall be available 230 VAC.
u. In the case of power disruption, each BACnet/IP Fieldbus controller shall support power failure recovery within 10 seconds and resume operation from where the disruption occurred.
v. The BACnet/IP Fieldbus controller shall be able to be plenum mounted (UL2043 compliant).
w. The BACnet/IP Fieldbus controller shall meet the open class standard of UL916 permitting its installation without secondary enclosure where appropriate.
x. The BACnet/IP Fieldbus controller shall comply with the following regulatory certifications:

1) CE - EMCD 2014/30/EU
2) CE LVD 2014/35/EU
3) FCC CFR 47 Part 15 Class B
4) RCM
5) RoHS 2011/65/EU
6) China RoHS SJ/T 11364-2014
7) UL2043 (Plenum space mounting)
8) UL916 Open-Energy Management equipment
9) UL916 Energy Management equipment

y. Intelligent Space Sensor Interface – The BACnet/IP Fieldbus controllers shall support an RJ45 communication port to communicate and power up to four (4) intelligent wall mount sensors without the use of on-board inputs or outputs.

1) It shall be possible to disable the RJ45 communication port.

z. Integrations - Connected Room:

1) The controller shall be capable of controlling lighting fixtures thru various open protocols listed below. This shall be achieved thru on-board I/O on the controller or via expansion modules (of the BACnet/IP controller) and will be capable of supporting the following:

a) The DALI expansion module shall be certified and capable of full DALI2 control for individual and groups of lights (up to thirty-two (32) ballasts or LED drivers and a maximum of sixteen (16) groups).
b) During zero (0) light output it shall be possible to fully shut down the ballasts thereby minimizing any leakage current.
c) The controller/expansion module shall be certified for multi-master functionality thereby allowing DALI pushbuttons sensors and dimmers to be mounted on the DALI communication bus.
d) The DALI expansion module shall be rated to 10A in total (Max 5A per channel).
e) The DALI expansion module shall support DALI version-1 control gear.
f) The DALI expansion module shall support DALI-1 version control gear.
g) The DALI expansion module shall support Discharge lamps.
h) The DALI expansion module shall support LED.

i) The DALI expansion module shall support color control (Device type 8).
j) The DALI expansion module shall support feedback from control gear (including lamp failure feedback).
k) The DALI expansion module shall support addressing and grouping of control gear.
l) The 0-10V expansion modules shall be capable of on/off/dim of light using 0-10V dimming signal.
m) During zero (0) light output it shall be possible to fully shut down the ballasts thereby minimizing any leakage current.
n) It shall be possible to interface and control lighting that are dimmed using Phase cut dimming the controller/interface shall be capable of automatically detecting the appropriate leading or trailing edge control mechanism that may be needed depending on the type of load.

2) The controller shall be capable of controlling blinds and shades thru various open protocols listed below. this shall be achieved thru on-board I/O on the controller or via expansion modules (of the BACnet/IP controller) and will be capable of supporting the following:

a) The controller/expansion modules shall be capable of interfacing with and controlling blind motors that uses low voltage Standard Motor Interface (SMI) communication.
b) The controller/expansion modules shall be capable of interfacing with and controlling blind motors that use high voltage SMI communication.
c) The controller/expansion modules shall be capable of interfacing with and controlling blind motors using low voltage (24V) relays.
d) The controller/expansion modules shall be capable of interfacing with and controlling blind motors using line voltage relays.

3) It shall be possible for the controller to interface with third-party Modbus devices sensors, pushbuttons, and glass touch panels.
4) It shall be possible for the controller to interface with KNX sensors and push button devices.
5) It shall be possible for the controller to communicate to wireless devices such as sensors, power meters, and wireless lighting control gateways via Zigbee 3.0.

a) Controllers using earlier Zigbee standards shall not be acceptable.

6) It shall be possible to rezone and partition spaces using graphical software, that works using floor plan maps and allows the user to create zones by positioning HVAC equipment, lights, blinds, and sensors directly on the map. It shall then be possible to assign them to zones.
7) It shall be possible to connect to four advanced sensors with capability for sensing occupancy and light levels. The sensor shall be powered by the controller and will not require batteries for operation.
8) It shall be possible to control lights/blinds and HVAC functions such as fan speed and temperature via an optional remote control that can be located anywhere conveniently within the room or mounted on the wall and communicates to the controller securely via blue-tooth.
9) It shall be possible for the controller to measure the power consumed by the different devices connected to the controller such as lighting HVAC and blinds.
10) Lighting Control Interfaces:

a) Mobile Based Personal Control Interface - an integrated mobile application shall provide current status of the light and blind in the room and enable each room occupant with the ability to:

- Dim, brighten lights and turn them on and off.
- And for blinds: tilt, vertical up or down

b) Ability to select scenes.
c) Control HVAC.

11) The Connected Room Solution will be fully programmable, capable of supporting different control strategies locally.
12) Standard applications shall be available for download from a central repository, which will allow common configurations such as those listed below to be easily configured.

a) Occupied state.
b) Unoccupied state.
c) Load Shed Mode.
d) Daylight Harvesting.
e) Time Clock Scheduling.

13) The integration modules shall comply with the following regulatory certifications:

a) CE - EMCD 2014/30/EU
b) CE LVD 2014/35/EU
c) FCC CFR 47 Part 15 Class B
d) RCM
e) RoHS 2011/65/EU
f) China RoHS SJ/T 11364-2014
g) UL2043 (Plenum space mounting)
h) UL916 Energy Management

21. The BACnet/IP Fieldbus controller for remote IO:

a. It shall be possible to extend Inputs/Outputs required in NSC or BACnet/IP Fieldbus Controllers over the IP network.
b. The BACnet/IP IO expansion device shall be equipped with 2x 10/100bT Ethernet communication ports with active switch supporting the following configurations:

1) Supporting IPv4 addressing.
2) Supporting Static IP setting, DHCP client and Auto-IP address acquisition.
3) It shall be possible to disable Ethernet port 2.

c. The BACnet/IP IO expansion device shall support daisy and RSTP topologies.
d. The BACnet/IP I/O expansion device shall be capable of sharing its local I/O resources with one (1) or multiple applications distributed across one (1) or multiple NSCs or BACnet/IP Fieldbus Controllers.
e. The BACnet/IP I/O expansion device shall support BACnet Alarm and Trend locally.
f. Outputs of the BACnet/IP I/O expansion device shall support user configurable fallback value that is triggered in case of communication disruption.

F. Commissioning Tool - The BACnet/IP Fieldbus controllers shall be supported via a dedicate mobile based commissioning tool for configuration, programming, air balancing and I/O checkout:

1. The Commissioning Tool shall be supported across: iOS, Android, and Windows 10 platforms.
2. The Commissioning Tool shall be available for download on App Store, Google Store and Windows Store.
3. Commissioning Tool Interface to BACnet/IP Fieldbus controllers shall be via Bluetooth or via a Wi-Fi access point on the LAN.
4. Functionality:

    a. Device Configuration – the Commissioning Tool shall be able to set or edit all Network configurations associated with the BACnet/IP Fieldbus controller.
    b. Programming – The Commissioning Tool shall be able to load offline engineered applications directly into the controller directly.
    c. Air Balancing:

        1) The Commissioning Tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.
        2) The Commissioning Tool shall be able to generate Air Balancing report.

    d. DALI Lighting Commissioning:

        1) The Commissioning tool shall allow the engineer to test the operation of DALI control gear.
        2) The commissioning tool shall allow the engineer to wink the DALI control gear.
        3) The commissioning tool shall indicate the status of the DALI control gear.

    e. 0-10V Lighting Commissioning:

        1) The Commissioning tool shall allow the engineer to test the operation of 0-10V lights.
        2) The commissioning tool shall allow the engineer to wink the 0-10V lights.

    f. Blind and Shade Commissioning:

        1) The Commissioning tool shall allow the engineer to test the operation of blinds and shades.

5. IO Checkout:

    a. The Commissioning Tool shall be able to support overriding of the outputs and reading value of inputs live that includes light and blind points and their configuration.
    b. The Commissioning Tool shall be able to support generation of I/O checkout report.

6. There shall be no limit to the number of Commissioning Tools that can be used on a network segment.

G. Intelligent Space Sensors - The BACnet/IP Fieldbus controller shall support a dedicated RJ45 communication port to communicate and power up to four (4) intelligent wall mount sensors without the use of on board inputs or outputs.

1. The Intelligent Space Sensor shall communicate with the BACnet/IP Fieldbus controller through the sensor port and via category 5 or category 6 cable.
2. The Intelligent Space Sensor shall provide two (2) RJ45 communication ports that will allow communication with parent BACnet/IP Field controller upstream and additional Intelligent Space Sensors downstream.
3. The Intelligent Space Sensor shall provide ambient space condition sensing without the use of hardware I/O.

H. Each Intelligent Space Sensor shall provide a color touch display with:

1. Minimum 2.4-by-2.4-inch display.
2. Backlit.

I. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ±0.2 °C (±0.4 °F) selectable for 0.1- or 1-degree display resolution of °F or °C.

1. Sensing Element: 10k Type 3 Thermistor.
2. Range: 0 to 50 °C (32 to 122 °F).

J. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from zero to one hundred percent (0-100%) RH Digital humidity indication (selectable for 0.1 or one percent (1%) RH with selectable display resolution of 0.1 or one percent (1%) RH.

1. Accuracy: Plus or minus two percent (±2%) RH.

K. The Intelligent Space Sensor shall have the option for support of CO_2 sensor with display resolution with 0 to 2000 ppm resolution.

1. Accuracy: ±30 ppm plus or minus two percent (±2%) of measured value.
2. Range: 0 to 2,000 ppm.
3. Operating Elevation: 0 to 16,000 ft.
4. Temperature Dependence: 0.11% FS per ˚F.
5. Stability: Less than two percent (<2%) of FS over life of sensor (fifteen (15) years).
6. Sensing Method: Non-dispersive infrared (NDIR), diffusion sampling.

2.6 BACNET FIELDBUS AND BACNET SDCUS

A. Networking:

1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
2. IP To Field Bus Routing Devices:

a. A Network Server Controller shall be used to provide this functionality.
b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

B. Field Bus Wiring and Termination:

1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
2. Each field bus shall have a termination resistor at both ends of each segment.
3. The field bus shall support the use of wireless communications.

C. Repeaters:

1. Repeaters are required to connect two (2) segments.
2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

D. Field Bus Devices:

1. General Requirements:

a. Devices shall have a light indicating that they are powered.
b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

E. Advance Application Controllers (B-AAC):

1. The key characteristics of a B-AAC are:

a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
c. The application to be executed by a B-AAC is created by an application engineer using the vendor's application programming tool.
d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
f. If local alarm message initiation is embedded, the B-AAC shall:

1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the alarm message.
2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.

g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.

i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
j. Shall support the “Who is” and “I am.” BACnet services.
k. Shall support the “Who has” and “I have.” BACnet services.

2. Analog Input Circuits:

a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two-point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.

3. Binary Input Circuits:

a. Dry contact sensors shall wire to the controller with two (2) wires.
b. An external power supply in the sensor circuit shall not be required.

4. Pulse Input Circuits:

a. Pulse input sensors shall wire to the controller with two (2) wires.
b. An external power supply in the sensor circuit shall not be required.
c. The pulse input circuit shall be able to process up to twenty (20) pulses per second.

5. True Analog Output Circuits:

a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The zero to one hundred percent (0-100%) control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: Zero to one hundred percent (0-100%) creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.

6. Binary Output Circuits:

a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.

7. Program Execution:

a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.

b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

8. Local Interface:

a. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:

1) Adjust application parameters.
2) Execute manual control of input and output points.
3) View dynamic data.

F. Application Specific Devices:

1. Application specific devices shall have fixed function configurable applications.
2. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.
3. Application specific devices shall be BTL certified.

G. Room Controllers:

1. For connected room solutions that do not require integrated lighting and blind busses built into a singular unit, the system shall include a BACnet MS-TP enabled controller specifically designed for room control.
2. The controller shall communicate via BACnet MS-TP. It should also be capable of MODBUS RTU communication.
3. The controller shall be capable of controlling fan coil units, cooling VVT zones with reheat, fin-tube radiators, cabinet heaters, radiant panel heaters, electric re-heat zones, terminal reheats, rooftop units (1H1C, 2H2C, 3H2C, MH2C), or heat pumps, if necessary.
4. The controller shall house an onboard temperature sensor, and options for onboard humidity and occupancy sensor.
5. The controller shall utilize a touch screen interface and have multiple options for casings and fasciae. The screen shall be a TFT transmissive LED backlit LCD touchscreen with at least five (5) color options.
6. Controller will have password protection to prevent unauthorized access to the configuration menu parameters.
7. The controller will have integrated Zigbee wireless communications with predefined profiles for Zigbee door and window switches, occupancy sensors, water leakage detectors, CO_2 sensors, and additional temperature and humidity sensors.
8. The controller will be capable of hosting at least 10 Zigbee sub devices.
9. The controller will be capable of being programmed with customizable scripts via the open programming language Lua. It shall be equipped with at least 256KB of SRAM with 80KB configurable/reserved for Lua scripting purposes.

2.7 DDC SENSORS AND POINT HARDWARE

A. Temperature Sensors:

1. Acceptable Manufacturers: Veris Industries, BMS Manufacturer Sensor
2. Classrooms and hallways shall have blank plate space sensors.
3. Offices and Conference Rooms to have setpoint adjustment.
4. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- 0.5 degrees F over a range of 40 to 100 degrees F.
5. Room Sensor: Standard space sensors shall be available in an off-white enclosure made of high impact ABS plastic for mounting on a standard electrical box. Basis-of-Design: **Veris TW Series**

    a. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
    b. Where a local display is specified, the sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.

6. Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless-steel probe. Useable in air handling applications where the coil or duct area is less than 14 square feet. Basis-of-Design: **Veris TD Series**
7. Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The average sensor tube shall contain at least one (1) thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Basis-of-Design: **Veris TA Series**
8. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless-steel for non-corrosive fluids below 250 degrees F and 300 series stainless-steel for all other applications. Basis-of-Design: **Veris TI Series**
9. Outside Air Sensor: Provide the sensing element on the building's north side. Sensing element shall be fully encapsulated in potting material within a stainless-steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. Operating range -40 to 122 F. Basis-of-Design: **Veris TO Series**
10. A pneumatic signal shall not be allowed for sensing temperature.

B. Humidity Wall Transmitter:

1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to plus or minus two percent (+/- 2%) at full scale.
3. Transmitter shall have replaceable sensing element.
4. Sensor type shall be thin-film capacitive.
5. Sensor element shall contain multipoint calibration on-board in nonvolatile memory.
6. Operating range shall be zero to one hundred percent (0-100%) RH noncondensing, 50 to 95 F.
7. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC.
8. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
9. Transmitter shall be available in an off-white enclosure made of high impact ABS plastic for mounting on a standard electrical box.
10. Transmitter shall have option of having an LCD display.
11. Transmitter shall have option of being NIST certified.

12. Transmitter shall have option of an integrated temperature sensor.
13. Basis-of-Design: **Veris HWL Series**

C. Humidity Duct Transmitter:

1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to plus or minus two percent (+/- 2%) at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless-steel probe.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.
6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory.
7. Operating range shall be zero to one hundred percent (0-100%) RH noncondensing, -40 to 122 F.
8. Output shall be 4-20 mA or 0-5/0-10 VDC.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall have option of being NIST certified.
11. Transmitter shall have option of an integrated temperature sensor.
12. Basis-of-Design: **Veris HD Series**

D. Humidity Outdoor Transmitter:

1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to plus or minus two percent (+/- 2%) at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless-steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.
6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory.
7. Operating range shall be zero to one hundred percent (0-100%) RH noncondensing, -40 to 122 F.
8. Output shall be 4-20 mA or 0-5/0-10 VDC.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall have option of being NIST certified.
11. Transmitter shall have option of an integrated temperature sensor.
12. Basis-of-Design: **Veris HO Series**

E. Carbon Dioxide Wall Transmitter:

1. Acceptable Manufacturer: Veris Industries
2. Sensor type shall be non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm plus or minus two percent (±2%) of measured value with annual drift of ±10 ppm. Minimum five-year recommended calibration interval.
4. Repeatability shall be ±20 ppm plus or minus one percent (±1%) of measured value.
5. Response Time shall be <60 seconds for ninety percent (90%) step change.
6. Outputs shall be field selectable Analog: 4-20mA or 0-5/0-10VDC.
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: 32° to 122°F (CO_2 only).
9. Output range shall be programmable 0-2000 or 0-5000 ppm.
10. Transmitter shall be available in an off-white enclosure for mounting on a standard electrical box.
11. Transmitter shall have an option of an LCD display for commissioning and provide additional faceplate to conceal LCD display where occupants may misinterpret CO_2 readings.
12. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor.

13. Basis-of-Design: **Veris CWL**

F. Carbon Dioxide Duct Transmitter:

1. Acceptable Manufacturer: Veris Industries
2. Sensor type shall be non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm plus or minus two percent (±2%) of measured value with annual drift of ±10 ppm. Minimum five-year recommended calibration interval.
4. Repeatability shall be ±20 ppm plus or minus one percent (±1%) of measured value.
5. Response Time shall be <60 seconds for ninety percent (90%) step change.
6. Outputs shall be field selectable Analog: 4-20mA or 0-5/0-10VDC with SPDT Relay 1A@30VDC.
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: 32° to 122°F.
9. Output range shall be programmable 0-2000 or 0-5000 ppm.
10. Enclosure shall not require remote pickup tubes and make use of integrated H-beam probe to channel air flow to sensor.
11. Enclosure lid shall require no screws and make use of snap on features for attachment.
12. Enclosure shall be made of high impact ABS plastic.
13. Transmitter shall have option of an LCD display.
14. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor.
15. Basis-of-Design: **Veris CDL**

G. Air Pressure Transmitters:

1. Acceptable Manufacturers: Veris Industries
2. Sensor shall be microprocessor profiled ceramic capacitive sensing element.
3. Transmitter shall have fourteen (14) selectable ranges from 0.1 – 10” WC.
4. Transmitter shall be plus or minus one percent (+/-1%) accurate in each selected range including linearity, repeatability, hysteresis, stability, and temperature compensation.
5. Transmitter shall be field configurable to mount on wall or duct with static probe.
6. Transmitter shall be field selectable for Unidirectional or Bidirectional.
7. Maximum operating pressure shall be two hundred percent (200%) of design pressure.
8. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC linear.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Response time shall be field selectable T95 in 20 sec or T95 in 2 sec.
11. Transmitter shall have an LCD display.
12. Units shall be field selectable for WC or PA.
13. Transmitter shall have provision for zeroing by pushbutton or digital input.
14. Transmitter shall be available with a certification of NIST calibration.
15. Basis-of-Design: **Veris Model PXU**

H. Liquid Differential Pressure Transmitters:

1. Acceptable Manufacturer: Veris Industries
2. Transmitter shall be microprocessor based.
3. Transmitter shall use two (2) independent gauge pressure sensors to measure and calculate differential pressure.
4. Transmitter shall have four (4) switch selectable ranges.
5. Transmitter shall have test mode to produce full-scale output automatically.
6. Transmitter shall have provision for zeroing by pushbutton or digital input.
7. Transmitter shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA.
8. Transmitter shall have field selectable electronic surge damping.
9. Transmitter shall have an electronic port swap feature.
10. Transmitter shall accept 12-30 VDC or 24 VAC supply power.

11. Sensor shall be 17-4 PH stainless-steel where it contacts the working fluid.
12. Performance:

    a. Accuracy shall be plus or minus one percent (±1%) F.S. and plus or minus two percent (±2%) F.S. for lowest selectable range.
    b. Long term stability shall be plus or minus one-quarter percent (±0.25%).
    c. Sensor temperature operating range shall be -4° to 185°F.
    d. Operating environment shall be 14° to 131°F; ten to ninety percent (10-90%) RH noncondensing.
    e. Proof pressure shall be 2x max. F.S. range.
    f. Burst pressure shall be 5x max. F.S. range.

13. Transmitter shall be encased in a NEMA 4 enclosure.
14. Enclosure shall be white powder-coated aluminum.
15. Transmitter shall be available with a certification of NIST calibration.
16. Transmitter shall be preinstalled on a bypass valve manifold.
17. Basis-of-Design: **Veris PW**

I. Current Sensors:

1. Current status switches shall be used to monitor fans, pumps, motors, and electrical loads. Current switches shall be available in split core models and offer either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris Industries.

J. Current Status Switches for Constant Load Devices:

1. Acceptable Manufacturer: Veris Industries
2. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
3. Visual LED indicator for status.
4. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 0.5 A to 175 A.
5. Normally open current sensor output. 0.1A at 30 VAC/DC.
6. Basis-of-Design: **Veris Model H608**

K. Current Status Switches for Constant Load Devices (Auto Calibration):

1. Acceptable Manufacturer: Veris Industries
2. General: Microprocessor based, self-learning, self-calibrating current switch. Calibration-free status for both under and overcurrent, LCD display, and slide-switch selectable trip point limits. At initial power-up automatically learns average current on the line with no action required by the installer.
3. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 2.5 A to 200 A.
4. Display: Backlit LCD; illuminates when monitored current exceeds 4.5A.
5. Nominal Trip Point: Plus or minus forty percent (±40%), plus or minus sixty percent (±60%), or on/off (user selectable).
6. Normally Open Current Sensor Output: 0.1A at 30 VAC/DC.
7. Basis-of-Design: **Veris Model H11D**

L. Current Status Switches for Variable Frequency Drive Application:

1. Acceptable Manufacturer: Veris Industries

2. General: Microprocessor controlled, self-learning, self-calibrating current sensor to detect motor undercurrent and overcurrent situations such as belt loss, coupling shear, and mechanical failure on variable loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory and relearn.
3. Visual LED indicator for status.
4. Alarm Limits: Plus or minus twenty percent (±20%) of learned current in every 5 Hz freq. band.
5. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 1.5 A to 150 A and from 12 to 115 Hz.
6. Normally Open Current Sensor Output: 0.1A at 30 VAC/DC.
7. Basis-of-Design: **Veris Model H614**

M. Liquid Flow, Insertion Type Turbine Flowmeter:

1. Acceptable Manufacturer: Veris Industries
2. General: Turbine-type insertion flow meter designed for use in pipe sizes 1½-inch and greater. Available in hot tap configuration with isolation valves and mounting hardware to install or remove the sensor from pipeline that is difficult to shut down or drain.
3. Performance:

    a. Accuracy: Plus or minus one percent (±1%) of rate over optimum flow range; ≥10 upstream and ≥5 downstream straight pipe diameters, uninterrupted flow
    b. Repeatability: Plus or minus one-half percent (±0.5%).
    c. Velocity Range: 0.3 to 20 FPS.
    d. Pressure Drop: 0.5 psi or less at 10 ft./sec. for all pipe sizes 1.5-inch dia and up.
    e. Pressure Rating: 1000 psi at 70°F.

4. Maximum Temperature Rating: 300°F.
5. Materials: Stainless-steel or brass body; stainless-steel impeller.
6. Transmitter:

    a. Power Supply: 12 - 30VAC or 8 - 35VDC.

        1) Output: Frequency 4-20 mA.

    b. Temperature Range: 14° to 150°F.
    c. Display: 8-character 3/8-inch LCD (Optional).
    d. Enclosure: NEMA 4, polypropylene with Viton® sealed acrylic cover.

7. Basis-of-Design: **Veris SDI series**

N. Water Control Valves:

1. Ball Valves:

    a. ½- to ¾-Inch Ball Valve:

        1) Forged brass body rated at no less than 600 psi, chrome plated brass ball with blowout proof stem or optional stainless-steel ball with blowout proof stem.
        2) Valves are to be in two-way and three-way configurations.
        3) Connection: Female NPT end fittings, Teflon® PTFE seat, characterizing disc glass filled PEEK providing equal percentage flow curve on two-way valve.

4) Operating Temperature: 20-250°F chilled or hot water with up to sixty percent (60%) glycol solution.
5) Two-way and Bypass port should be ANSI Class IV (0.01% of Cv) seat leakage.
6) Rangeability must be at least 300:1.
7) Tool-less actuator connection.
8) System Static Pressure Limit should be 600 psig.
9) Acceptable Manufacturers: Belimo, Schneider Electric VBB/VBS Ball Valves, or approved equal.

b. ½- to 3-Inch 2-Way and ½- to 2-Inch 3-Way Ball Valves:

1) Valves must be for control of hot or chilled water, or solutions of up to fifty percent (50%) glycol.
2) Ball valves must have close-offs of 40-130 psi depending on size.
3) Valves will provide CVs from 0.33-266 depending on size.
4) Valve characterizing insert, is to be made of glass-filled Noryl™ and provide equal percentage flow.
5) Valve body is to be made of forged brass ASTM B 283 and rated for static pressure of 360 psi at fluid temperatures of 20-250°F (-7-121°C).
6) All valves are to have balls made of nickel/chromium plated brass with two-way valves having stainless-steel balls as an option. All valve stems are to be stainless-steel with reinforce Teflon® EPDM O-ring seals.
7) 2-way valves are to be ANSI Class IV (0.01% of Cv) shutoff. 3-way valves are to be ANSI Class IV (0.01% of Cv) piped coil-side outlet to port A only.
8) Fluid (water) temperature is a minimum 20°F (-7°C) and a maximum of 250°F (121°C).
9) Acceptable Manufacturers: Belimo, Schneider Electric VB-2000, or approved equal.

2. Globe Valves (Bronze ½- to 2-Inch):

a. Control Valves: Factory fabricated, with body material, and pressure class based on maximum pressure and temperature rating of piping system with a body rating of not less than 400 psig at 150°F, 321 psig at 281°F per ANSI B16.15.
b. Valves two-way NPS 2” and Smaller: Operator, stem and plug assembly, and spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Material grade properties must meet the fluid temperature and pressure requirements:

1) Standard duty bronze body, 316 stainless-steel vertical stem, brass plug, soft seal, and bronze seat, renewable packing cartridge, and screwed/sweat/flared ends. Valves shall have allowable media temperature of 20°F-281°F to assure reliability with dual temperature applications.
2) Heavy duty bronze body, 316 stainless-steel vertical stem, 316 stainless-steel plug, soft seal, and 316 stainless-steel seat, renewable packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F-340°F to assure to assure reliability with dual temperature applications.
3) High temperature bronze body, 316 stainless-steel vertical stem, 316 stainless-steel plug, and 316 stainless-steel seat, renewable packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F-400°F.

c. Two-way fluid system globe valves shall have the following characteristics:

1) Rangeability: Greater than 100:1 for all valves with flow coefficients of 0.4 and higher to provide stable control under light load conditions.
2) Maximum Allowable Seat Leakage: Standard and heavy-duty valves must be designed to meet ANSI Class V (0.0005 ml per minute per “of orifice diameter per psi differential) up to 35 psi close off differential pressure and ANSI Class IV seat leakage (maximum 0.01% of full open valve capacity) above 35 psi with appropriate actuator. High temperature valves must meet ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).
3) The valve must be able to operate with a full-open operating differential of no less than 87 psi.
4) Flow Characteristics: Modified equal percentage characteristics for standard duty water applications and modified linear for heavy duty and high temperature steam applications with gradual opening for light loads.
5) Sizing:

    a) Two Position Water: Water: Line size or size using a differential pressure of 1 psi.
    b) Modulating Water: 5 psi or twice the load pressure drop.
    c) Pressure drop across steam valve at a maximum flow of eighty percent (80%) of inlet pressure up to 15 psig and forty-two percent (42%) of absolute (gage pressure + 14.7) inlet pressure above 15 psig inlet.
    d) 100 psi saturated steam maximum inlet pressure for heavy duty bronze body globe valves ½- to 2-inch.
    e) 150 psi saturated steam maximum inlet pressure for high temperature bronze body globe valves ½- to 2-inch.
    f) 35 psi saturated steam maximum inlet pressure for standard duty bronze body globe valves ½- to 2-inch”.

d. Valves 3-Way Mixing (Two (2) Inlets and One (1) Outlet) NPS 2” and Smaller:

    1) Operator, stem and plug assembly, and spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Material grade properties must meet the fluid temperature and pressure requirements:

        a) Standard duty bronze body, 316 stainless-steel vertical stem, brass plug, and bronze seat, renewable packing cartridge, and screwed or sweat ends. Valves shall have allowable media temperature of 20°F-281°F to assure reliability with dual temperature applications.
        b) Heavy duty bronze body, 316 stainless-steel vertical stem, 316 stainless-steel plug, and 316 stainless-steel seat, renewable disc and packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F-340°F to assure reliability with dual temperature applications.

e. 3-Way mixing hydronic system globe valves shall have the following characteristics:

    1) Rangeability: Greater than 100:1 for all valves to provide stable.
    2) Maximum Allowable Seat Leakage: A port must be designed to meet ANSI Class V (0.0005 ml per minute per “of orifice diameter per psi differential) up to 35 psi close off differential pressure and ANSI IV seat leakage (maximum 0.01% of full open valve capacity) above 35 psi with appropriate actuator. B port must meet ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).

3) The valve must be able to operate with a full-open operating differential of 87 psi.
4) Flow Characteristics: Modified linear characteristics with gradual opening for light loads.
5) Sizing: Modulating Water: Minimum 5 psi or at least equal to the load pressure drop.

f. Valves 3-Way Diverting (One (1) Inlet and Two (2) Outlets) NPS 2" and Smaller:

1) Operator, stem and plug assembly, and spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Valves must be designed specifically for diverting service, and mixing valves designed for mixing service must not be used for diverting applications. Material grade properties must meet the fluid temperature and pressure requirements:

a) Standard duty bronze body, 316 stainless-steel vertical stem, brass plug, and bronze seat, renewable disc and packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F-281°F to assure reliability with dual temperature applications.

g. 3-Way diverting hydronic system globe valves shall have the following characteristics:

1) Rangeability: Greater than 100:1 for all valves to provide stable control under light load conditions.
2) Maximum Allowable Seat Leakage: ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).
3) Maximum Allowable Pressure Differential: 35 psi in.an open position.
4) Flow Characteristics: Modified linear characteristics with gradual opening for light loads.
5) Sizing:

a) Modulating Water: Minimum 5 psi or at least equal to the load pressure drop.

h. Required Certifications: Pressure Equipment Directive (PED 97/23/EC), RoHS (Restriction of Hazardous Substances) and REACH (Regulation, Evaluation, Authorization, and Restriction of Chemicals), Canadian Registration Number.
i. Valve and Operator: To assure maximum performance and operation of the valve assembly both the valve and the actuator must be tested and approved by the valve manufacturer to assure compatibility of all components and performance to the specifications.
j. Acceptable Manufacturers: Belimo, Schneider Electric Venta VB-7000, or approved equal.

3. Butterfly Valves:

a. Valve body are to be polyester coated iron ASTM A 126 lug mating with ANSI class 125/150 flanges.
b. Disc Type: Ductile iron nylon 11 coated.
c. Valve Stem:

1) 2- to 8-Inch: 316 stainless-steel double D stem.
2) 10- to 12-Inch: 316 stainless-steel double D stem.

3) 14-Inch and Larger: Stainless-steel round shaft woodruff key slot.

d. Valve Seat: EPDM tongue and groove seat and molded O-ring flange seat.
e. Flow Characteristics: Modified equal percentage.
f. Close-Off Pressure Rating: Bubble-tight shutoff (no leakage).
g. Valve Fluid Temperature Rating: -40-250°F (-40-121°C)
h. Valve will have 2-inch extended neck (because of heat).
i. Valve must except pneumatic or electric/electronic actuators
j. Valves must have a minimum of a 2-year warranty.

4. Flanged Valves:

a. Bodies: Shall be American Factory fabricated with ASTM A 126 Class B cast iron body material with the pressure class within the maximum pressure and temperature rating of the piping system. (125 body rating with not less than 200 psig at 150°F, decreasing to 169 psig at 281F per ANSA B16.1).
b. Serviceability: 2-way valve operators, stem and plug assemblies, and spring-loaded PTFE/EPDM valve stem packing cartridges must be removable for future replacement to restore the valves back to their original condition.
c. Construction: Material grades must meet the fluid temperature and pressure requirement temperatures of 20°F-281°F to assure reliability throughout all application temperature ranges.
d. Packings: Shall be cartridges suitable for replacement as units withstanding the full operating temperature ranges, including daily and seasonal fluctuations of water, sixty percent (60%) glycol and steam fluids.
e. Characteristics:

1) Rangeability: Two-way,100:1 and greater for stable control under light load.
2) Shutoff, 2-Way: Leakage Allowed: ANSI Class IV (0.01% of max flow).
3) 3-Way Leakage Allowed: ANSI Class III (0.1% of max flow).
4) Flow Curves: 2-way modified equal percentage characteristic.
5) Mixing and Diverting: Linear, modified with gradual opening for light loads.

f. Piping:

1) Diverting valves, with the common port at the bottom can be used for mixing.
2) Mixing valves with the common port at the end must not be used for diverting applications.

g. Sizing:

1) Two Position Water: Line size or size using a differential pressure of 1 psi.
2) Modulating Water: 5 psi or twice the load pressure drop.
3) Steam, 2-Way: Maximum pressure drops across the valve at a maximum flow of eighty percent (80%) of inlet pressure up to 15 psig. Above 15 psig inlet, forty-two percent (42%) of absolute (gage pressure + 14.7) inlet pressure.

h. Certifications for All Models: Pressure Equipment Directive (PED 97/23/EC), RoHS (Restriction of Hazardous Substances) and REACH (Regulation, Evaluation, Authorization, and Restriction of Chemicals.
i. Acceptable Manufacturers: Belimo, Schneider Electric VB-8000 and VB-9000 valves or approved equal.

O. Steam Control Valves:

1. ½- to 2-Inch Steam Service Designed Globe Valve:

a. Body material, and pressure class based on maximum pressure and temperature rating of piping system with a body rating of not less than 400 psig at 150°F, 321 psig at 281°F per ANSI B16.15.

b. High temperature spring-loaded PTFE/EPDM valve stem packing cartridge must be removable for future replacement to restore the valves back to their original condition. Material grade properties must meet the fluid temperature and pressure requirements:

1) Standard duty bronze body, 316 stainless-steel vertical stem, brass plug, soft seal, and bronze seat, renewable packing cartridge, and screwed/sweat/flared ends. Valves shall have allowable media temperature of 20°F-281°F to assure reliability with dual temperature applications.
2) Heavy duty bronze body, 316 stainless-steel vertical stem, 316 stainless-steel plug, soft seal, and 316 stainless-steel seat, renewable packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F-340°F to assure reliability with dual temperature applications.
3) High temperature bronze body, 316 stainless-steel vertical stem, 316 stainless-steel plug, and 316 stainless-steel seat, renewable packing cartridge, and screwed ends. Valves shall have allowable media temperature of 20°F-400°F.

c. Two-way fluid system globe valves shall have the following characteristics:

1) Rangeability: Greater than 100:1 for all valves with flow coefficients of 0.4 and higher to provide stable control under light load conditions.
2) Maximum Allowable Seat Leakage: Standard and heavy-duty valves must be designed to meet ANSI Class V (0.0005 ml per minute per “of orifice diameter per psi differential) up to 35 psi close off differential pressure and ANSI Class IV seat leakage (maximum 0.01% of full open valve capacity) above 35 psi with appropriate actuator. High temperature valves must meet ANSI Class III seat leakage (maximum 0.1% of full open valve capacity).
3) The valve must be able to operate with a full-open operating differential of no less than 87 psi.
4) Flow Characteristics: Modified equal percentage characteristics for standard duty water applications and modified linear for heavy duty and high temperature steam applications with gradual opening for light loads.
5) Sizing:

a) Pressure drop across steam valve at a maximum flow of eighty percent (80%) of inlet pressure up to 15 psig and forty-two percent (42%) of absolute (gage pressure + 14.7) inlet pressure above 15 psig inlet.
b) 100 psi saturated steam maximum inlet pressure for heavy duty bronze body globe valves ½- to 2-inch.
c) 150 psi saturated steam maximum inlet pressure for high temperature bronze body globe valves ½- to 2-inch.
d) 35 psi saturated steam maximum inlet pressure for standard duty bronze body globe valves ½- to 2-inch.

6) Certifications for All Models: Pressure Equipment Directive (PED 97/23/EC), RoHS (Restriction of Hazardous Substances) and REACH (Regulation, Evaluation, Authorization, and Restriction of Chemicals).
7) Acceptable Manufactures: Belimo, Schneider Electric VB-7000 valves, or approved equal.

2. 2½- to 6-Inch Steam Service Designed Globe Valves:

a. Bodies: Shall be American Factory fabricated with ASTM A 126 Class B cast iron body material with the pressure class within the maximum pressure and temperature rating of the piping system. (125 body rating with not less than 200 psig at 150°F, decreasing to 169 psig at 281F per ANSA B16.1).
b. Serviceability: 2-way valve operators, stem and plug assemblies and spring-loaded PTFE/EPDM valve stem packing cartridges must be removable for future replacement to restore the valves back to their original condition.
c. Construction: Material grades must meet the fluid temperature and pressure requirement temperatures of 20°F-281°F to assure reliability throughout all application temperature ranges.
d. Packings: Shall be cartridges suitable for replacement as units withstanding the full operating temperature ranges, including daily and seasonal fluctuations of water, sixty percent (60%) glycol and steam fluids.
e. Characteristics:

1) Rangeability: Two-way,100:1 and greater for stable control under light load.
2) Shutoff, 2-Way: Leakage allowed: ANSI Class IV (0.01% of max flow).
3) Flow Curves: 2-way modified equal percentage characteristic.

f. Sizing:

1) Steam, 2-Way: Maximum pressure drops across the valve at a maximum flow of eighty percent (80%) of inlet pressure up to 15 psig. Above 15 psig inlet, forty-two percent (42%) of absolute (gage pressure + 14.7) inlet pressure.

g. Certifications for All Models: Pressure Equipment Directive (PED 97/23/EC), RoHS (Restriction of Hazardous Substances) and REACH (Regulation, Evaluation, Authorization, and Restriction of Chemicals.
h. Acceptable Manufacturers: Belimo, Schneider Electric VB-8000 and VB-9000 valves or approved equal.

P. Control Valve Actuators:

1. ½- to ¾-Inch Ball Valve Actuators:

a. Size for torque required for valve close-off pressure for system design.
b. Coupling: Direct coupled to valve body without use of external devices/tools.
c. Auxiliary End Switch (optional) to be SPST 24 Vac/Vdc,101 mA to 5 mA maximum on selected two-position models.
d. Controller Signal Two-position, Floating or Proportional (0-5 Vdc, 0-10 Vdc, 5-10 Vdc, or 4-20 mA dc). Design allows for change via DIP switches without removal of cover.
e. Manual operating lever and position indicator must be standard.
f. Power Requirements: 24 Vac for floating, proportional, and 110-230 Vac for two-position multi-voltage types.

g. Actuators must be available with either Spring Return (SR) or Non-Spring Return (NSR) models.
h. Operating Temperature: Limit Floating is to be 32-140°F (0-60°C). Proportional 32-140°F (0-60°C). Two-Position 32-169°F (0-76°C).
i. Wiring (Depending on Model): Removable Terminal Block, 10 ft. Plenum Cable, 18 in. Appliance Wire.
j. Locations must be rated NEMA 2, IEC IP31. (Indoor Use Only.) Actuators with terminal block or plenum cable leads are plenum rated per UL file number E9429.
k. Agency Listings: ISO 9001, cULus, and CE.
l. Acceptable Manufacturers: Belimo, Schneider Electric VBB/VBS, or approved equal.

2. ½- to 3-Inch 2-Way and ½- to 2-Inch 3-Way Ball Valves Actuators:

a. Size for torque required for valve close-off pressure for system design.
b. Actuators are to be available in spring return (SR) and non-spring return (NSR) models. Spring Return (SR) actuators are to provide a choice to return direction.
c. Actuators are to be available in models for two-position, floating and proportional control.
d. All actuator models are to be equipped with pigtail leads, manual override, and auxiliary switch(es).
e. Operating temperatures' Floating Non-Spring Return (NSR) with 33 lb.-in. of torque must be -25 to 130 °F (-32 to 55°C). All other actuators are to -22 to 140 °F (-30 to 60 °C).
f. Actuators must be NEMA 2 rated.
g. Agency Listings: ISO 9001, cULus, and CE.
h. Acceptable Manufacturers: Belimo, Schneider Electric VB-2000, or approved equal.

3. ½- to 2-Inch Bronze, Linear Globe Valve Actuators – 67 or 78 lbs. Force:

a. Actuator must have bi-color LED status indication for motion indication, auto calibration, and alarm notification.
b. When the actuator is properly mounted must have a minimum of a NEMA 2 (IP53) rating.
c. Actuators are to be non-spring return.
d. Actuators are to be floating (used for two-position) or proportional models.
e. Proportional models will have optional models with a position output signal with field selectable 2-10 Vdc and 0-10 Vdc input signals and selectable input signal direct or reverse acting.
f. Actuator must have auto calibration which provides precise control by scaling the input signal to match the exact travel of the valve stem.
g. Actuators must come in models with Pulse Width Modulated (PWM) with field selectable 0.59 to 2.93 sec and 0.1 to 25.5 sec input signal ranges with a position output signal.
h. Actuators must have manual override with automatic release.
i. Models with position feedback output signal include field selectable 2-10 Vdc or 0-5 Vdc output signal.
j. Removable wiring screw terminal with ½-inch conduit opening.
k. Actuator operating temperature ranges:

1) When controlling fluid up to 266°F (130°C) = ambient air temperature is to be 23-131°F (-5-55°C).
2) Fluid up to 281°F (138°C) = 23-127°F (-5-53°C).
3) Fluid up to 340°F (171°C) = 23-115°F (-5-46°C).
4) Fluid up to 400°F (204°C) = 23-102°F (-5-39°C).

l. Actuator Agency Listings: cUL-us LISTED mark, NEMA 2, NEC class 2 FCC part-15 class B, Canadian ICES-003, ESA registered, Plenum rated per UL 20430.
m. Acceptable Manufacturers: Belimo, Schneider Electric MG350V, or approved equal.

4. ½- to 2-Inch Bronze, Linear Globe Valve Actuators – 105 lbs. Force:

a. Actuators must have Two-Position, Floating, and Proportional models.
b. Proportional models will have a controller input signal of either a 0-10 Vdc, 2-10 Vdc, 4-20 mAdc, 0-3 Vdc, or 6-9 Vdc. Control function direct/reverse action is switch selectable on most models.
c. Actuator force is to be 105 lb. (467 newton) with ½-inch nominal linear stroke.
d. Power requirements 24 Vac, 120 Vac or 230 Vac depending on model.
e. Actuator housings rated for up to NEMA 2/IP54.
f. Actuator is to have overload protection throughout stroke.
g. Actuator operating temperature is -22-140°F (-30-60°C) up to a maximum valve fluid temperature of 366°F (186°C).
h. Actuator must automatically set input span to match valve travel.
i. Actuator must have manual override to allow positioning of valve and preload.
j. Actuator is to be spring return.
k. Actuator is to mount directly to valves without separate linkage.
l. Actuator Agency Listings: UL 873, CUL: UL.
m. Acceptable Manufacturers: Belimo, Schneider Electric SmartX Mx51-7103, or approved equal.

5. ½- to 2-Inch Bronze, Linear Globe Valve Actuators – 220 lbs. Force:

a. Actuators must have Two-Position for a SPST controller, Floating for a SPST controller, and Proportional models will a controller input signal of either a 0-10 Vdc, 2-10 Vdc, 4-20 mAdc, or 6-9 Vdc. Control function direct/reverse action is jumper selectable.
b. Actuator is to be spring return.
c. Actuator will have 220 lb. force (979 newton) with ½-inch or 1-inch nominal linear stroke.
d. Feedback on proportional model with 2-10 Vdc (max. 0.5 mA) output signal or to operate up to four like additional slave actuators.
e. Actuator operating temperature ranges are 0-140°F (-18-60°C) up to a maximum valve fluid temperature of 281°F (138°C), 0-120°F (-18-49°C) up to a maximum valve fluid temperature of 300°F (149°C), 0-100°F (-18-38°C) up to a maximum valve fluid temperature of 340°F (171°C), and 0-90°F (-18-32°C) up to a maximum valve fluid temperature of 366°F (186°C).
f. Actuator must automatically set input span to match valve travel.
g. Actuator is to have a 24 Vac power supply on Two-position and Proportional models and 120 Vac on Two-position models.
h. Actuator housings rated for up to NEMA 2/IP54.
i. Actuator must have manual override to allow positioning of valve and preload.
j. Actuator is to mount directly to vales without separate linkage.
k. Actuator Agency Listings: UL 873, CUL: UL.
l. Acceptable Manufacturers: Belimo, Schneider Electric SmartX Mx51-720x, or approved equal.

6. ½- to 2-Inch Bronze, Linear Globe Valve Actuators with Linkage SR:

a. Actuators with 35, 60, 133, or 150 lb.-in of force depending on model.
b. Actuator housings rated for up to NEMA 2/IP54 with a 150 lb.-in. rated a NEMA 4.
c. Actuators are to be spring return.

d. Actuators are to have Two-position, Floating and Proportional models.
e. Actuators must have overload protection throughout rotation.
f. Actuator have an optional built-in auxiliary switch to provide for interfacing or signaling on selected models.
g. Actuator Agency listings: UL-873, C22-2 No.24-83, CUL0.
h. Acceptable Manufacturers: Belimo, Schneider Electric SmartX, or approved equal.

7. ½- to 2-Inch Bronze Body, Linear Globe Valve Actuators with Linkage SR and NSR:

a. Actuators are to be either floating SPDT control or proportional control 0-10, 2-10 Vdc, or 4-20 mA with a 500-ohm resistor included.
b. Actuators are to be direct/reverse with selectable DIP switches.
c. Actuators are to have 90 lb., 180 lb., or 337 lb. of force on Non-Spring Return (NSR); 157 lb. of force on the Spring Return model. Note: Not every actuator is for every valve.
d. Actuators are to be powered with 24 Vac or 24 Vdc.
e. All Non-Spring Return (NSR) actuators are to be NEMA 2, vertical mount only. Spring Return (SR) actuators are to have NEMA 4 models.
f. Actuators must have manual override to allow positioning of the valve.
g. Actuators must have selectable valve sequencing and flow curves of either equal percentage or linear.
h. Actuators must have feedback.
i. Actuators must have internal torque protection throughout stroke.
j. Actuator operating temperatures are 14-122°F (-10-50°C) for chilled water applications, 14-113°F (-10-45°C) up to a maximum valve fluid temperature of 281°F (138°C), 14-107°F (-10-42°C) up to a maximum valve fluid temperature of 300°F (149°C), 14-100°F (-10-38°C) up to a maximum valve fluid temperature of 340°F (171°C), and 14-90°F (-10-32°C) up to a maximum valve fluid temperature of 366°F (186°C).
k. Actuator Agency listings (North America) UL873, cULus, RCM, CE.
l. Acceptable Manufacturers: Belimo, Schneider Electric Forta M400A-VB, M800A-VB, M900A and M1500x-VB screw mounted on Venta VB7000s, or approved equal.

8. 2½- to 6-Inch Cast Iron Flanged Globe Valve Linear Actuators with Linkage:

a. Actuators are to be either floating SPDT control or proportional control 0-10, 2-10 Vdc, or 4-20 mA with a 500-ohm resistor included.
b. Actuators are to direct/reverse acting with selectable DIP switch.
c. Actuators are to have 180 lb. or 337 lb. of force.
d. Actuators will need a 24 Vac or Vdc power supply.
e. Actuators are to be rated NEMA 2, vertical mount only.
f. Actuators must have manual override to allow positioning of the valve.
g. Actuators must have selectable valve sequencing and flow curves of either equal percentage to linear, a 2-10 Vac feedback.
h. Actuators must have Internal torque protection throughout stroke.
i. Actuator operating temperatures are 14-122°F (-10-50°C) for chilled water applications, 14-113°F (-10-45°C) up to a maximum valve fluid temperature of 281°F (138°C), and 14-107°F (-10-42°C) up to a maximum valve fluid temperature of 300°F (149°C).
j. Actuator Agency Listings (North America) UL873, cULus, RCM, CE.
k. Acceptable Manufacturers: Belimo, Schneider Electric Forta M800A and M1500A, or approved equal.

9. 2½- to 6-Inch Cast Iron Flanged Globe Valve Actuators – 220 lbs. Force:

a. Actuators must have Two- Position for a SPST controller, Floating for a SPST controller, and Proportional models will a controller input signal of either a 0-10 Vdc, 2-10 Vdc, 4-20 mAdc, or 6-9 Vdc. Control function direct/reverse action is jumper selectable.
b. Actuator is to be spring return.
c. Actuator will have 220 lb. force (979 newton) with ½- or 1-inch nominal linear stroke.
d. Feedback on proportional model with 2-10 Vdc (max. 0.5 mA) output signal or to operate up to four (4) like additional slave actuators.
e. Actuator must automatically set input span to match valve travel.
f. Actuator operating temperature is 0-140°F (-18-60°C) up to a maximum valve fluid temperature of 300°F (149°C).
g. Actuator is to have a 24 Vac power supply on Two-position and Proportional models and 120 Vac on Two-position models.
h. Actuator housings rated for up to NEMA 2/IP54.
i. Actuator must have manual override to allow positioning of valve and preload.
j. Actuator is to mount directly to vales without separate linkage.
k. Actuator Agency Listings: UL 873, CUL: UL.
l. Acceptable Manufacturers: Belimo, Schneider Electric SmartX Mx61-720x, or approved equal.

10. 2½- to 6-Inch Cast Iron Flanged Globe Valve Actuators with Linkage SR:

a. Actuators with 60, 133, or 150 lb.-in of force depending on model.
b. Actuator housings rated for up to NEMA 2/IP54 with a 150 lb.-in. rated a NEMA 4.
c. Actuators are to be spring return.
d. Actuators are to have Two-position, Floating and Proportional models.
e. Actuators must have overload protection throughout rotation.
f. Actuator have an optional built-in auxiliary switch to provide for interfacing or signaling on selected models.
g. Actuator Agency Listings: UL-873, C22-2 No.24-83, CUL0.
h. Acceptable Manufacturers: Belimo, Schneider Electric SmartX, or approved equal.

11. 2- to 18-Inch 2-Way and 2- to 16-Inch 3-Way Linear Butterfly Valve Actuator with Linkage NSR:

a. The butterfly valve actuators are to be Non-Spring Return (NSR) two-position and proportional taking 0-10 Vdc or 4-20 mA models. All actuators are to be NEMA 4, manual override (hand wheel) two (2) auxiliary switches, and built-in heater.
b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
c. Actuators must be available in 24 Vac and 120 Vac models.
d. Actuators must have Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one actuator to another.
e. Proportional models must have feedback of 0-10 Vdc or 4-20 mA.
f. Actuator operating temperature shall be -40-150°F (-40-60°C).
g. Actuator Agency Listings (North America): UL, CSA, and CE.
h. Acceptable Manufacturers: Belimo, Schneider Electric S70, or approved equal.

12. 2- to 4-Inch 2-Way and 3-Way Butterfly Valve Actuators SR:

a. The butterfly valve actuators are to be Spring Return (SR) two-position and proportional taking 2-10 Vdc or 4-20 mA models. All Actuators are to be NEMA 2.
b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
c. Actuators must be available in 24 Vac models.

d. Actuators shall have two (2) SPDT auxiliary switch models.
e. Actuators must have Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one (1) actuator to another.
f. Proportional models must have feedback of 2-10 Vdc or 4-20 mA.
g. Actuator operating temperature shall be -22-140°F (-12-60°C).
h. Actuator Agency Listings (North America): UL, CSA, and CE.
i. Acceptable Manufacturers: Belimo, Schneider Electric SmartX Mx-41-7153, or approved equal.

13. 2- to 6-Inch 2-Way and 3-Way Butterfly Valve Actuators NSR:

a. The butterfly valve actuators are to be Non-Spring Return (NSR) two-position and proportional taking 0-10 Vdc or 4-20 mA models. All Actuators are to be NEMA 2.
b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
c. Actuators must be available in 24 Vac models.
d. Actuators shall have two (2) SPDT auxiliary switch models.
e. Actuators must have [Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one (1) actuator to another.
f. Proportional models must have feedback of 2-10 Vdc or 4-20 mA.
g. Actuator operating temperature shall be -4-122°F (-2-50°C).
h. Actuator Agency Listings (North America): UL, CSA, and CE.
i. Acceptable Manufacturers: Belimo, Schneider Electric SmartX NR-22xx-5xx, or approved equal.

Q. Dampers:

1. Automatic dampers furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS system supplier. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
2. Damper frames are to be constructed of 13-gauge galvanized sheet steel mechanically joined with linkage concealed in the side channel to eliminate noise as friction. Compressible spring stainless steel side seals and acetyl or bronze bearings shall also be provided.
3. Damper blade width shall not exceed eight inches. Seals and 3/8-inch square steel zinc plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.
4. For high performance applications, control dampers will meet or exceed the UL Class I leakage rating.
5. Control and smoke dampers shall be Ruskin or approved equal.
6. Provide opposed blade dampers for modulating applications and parallel blade for two-position control.

R. Damper Actuators:

1. Direct-coupled type non-hydraulic designed for minimum one hundred thousand (100,000) full-stroke cycles at rated torque.
2. Direct-coupled damper actuators must have a 5-year warranty.
3. Size for torque required for damper seal at maximum design conditions and valve close-off pressure for system design.
4. Direct-coupled damper actuators should accommodate 3/8-, ½-, and 1.05-inch round or 3/8-, ½-, and ¾-inch square damper shafts.

5. Actuator Operating Temperature Minimum Requirements: 44, 88, and 133 lb.-in. are 25°F-130°F (–32°C-55°C), 30, 35, 60, 150, and 300 lb.-in. are -25°-140°F (-30°C- 60 °C), and 270 are -22°-122°F (-30°C-50 °C).
6. Overload protected electronically throughout rotation except for selected Floating actuators the have a mechanical clutch.
7. Spring Return Actuators: Mechanical fail safe shall incorporate a spring-return mechanism.
8. Non-Spring Return Actuators shall stay in the position last commended by the controller with an external manual gear release to allow positioning when not powered.
9. Power Requirements: 24Vac/dc.
10. Proportional Actuators controller input range from 0-10 Vdc, 2-10 Vdc, or 4-20 mA models.
11. Housing: Minimum requirement NEMA type 2 with NEMA type 4 available for applications requiring higher ratings.
12. Actuators with a microprocessor should not be able to be modified by an outside source (cracked or hacked).
13. Actuators of 133 and 270 lb.-in. of torque or more should be able to be tandem mount or “gang” mount.
14. Agency Listings: ISO 9001, cULus, CE, and CSA.
15. Acceptable Manufacturers: Belimo, Schneider Electric SmartX Actuators, or approved equal.

S. Airflow Measuring Stations:

1. Provide a thermal anemometer using instrument grade self-heated thermistor sensors with thermistor temperature sensors.
2. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of plus or minus two percent (+/-2%) over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.
3. Acceptable Manufacturers: Ebtron, Air Monitor, or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Section 230000 “Basic Mechanical Requirements” and Drawings.

B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.

C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

D. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

E. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer’s written instructions and recommendations, and as indicated on the Drawings.

F. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

G. Demolition:

1. Remove controls which do not remain as part of the building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor.

H. Access to Site:

1. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.

I. Code Compliance:

1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations.

J. Cleanup:

1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

3.2 SYSTEM ACCEPTANCE TESTING

A. All application software will be verified and compared against the sequences of operation.

B. Control loops will be exercised by inducing a setpoint shift of at least ten percent (10%) and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.

C. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the Owner.

D. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the Owner.

E. Perform an operational test of each third-party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

3.3 INSTALLATION

A. Hardware Installation Practices for Wiring:

1. All controllers are to be mounted vertically and per the manufacturer's installation documentation.

2. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral, and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
3. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
4. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.
5. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exception: Metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
6. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
7. Wires are to be kept a minimum of 3 inches from hot water, steam, or condensate piping.
8. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
9. Wire will not be allowed to run across telephone equipment areas.
10. Provide fire caulking at all rated penetrations.

B. Installation Practices for Field Devices:

1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout one hundred percent (100%) of the stroke.
3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to one hundred fifty percent (150%) of the rated coil voltage.
4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
5. For duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low-pressure port shall be left open to the plenum area at the point that the high-pressure port is tapped into the ductwork.
6. For building static pressure sensors, the high-pressure port shall be inserted into the space via a metal tube. Pipe the low-pressure port to the outside of the building.

C. Wiring, Conduit, and Cable:

1. All wire will be copper and meet the minimum wire size and insulation class listed below:

    a. Power – 12 Gauge – 600 Volt.
    b. Class One – 14 Gauge Std. – 600 Volt.
    c. Class Two – 18 Gauge Std. – 300 Volt.
    d. Class Three – 18 Gauge Std. – 300 Volt.
    e. Communications – Per Mfr.

2. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.
3. Where different wiring classes terminate within the same enclosure, maintain clearances, and install barriers per the National Electric Code.
4. Wiring in EMT conduit where exposed and in mechanical rooms. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum ¾-inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to

moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

5. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be used in exterior locations and interior locations subject to moisture.
6. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal 4-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
7. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Wiring to be installed above drop ceilings with plenum rated wire.
8. Fiber optic cable shall include the following sizes: 50/125, 62.5/125 or 100/140.
9. Only glass fiber is acceptable, no plastic.
10. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS system supplier shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

D. Enclosures:

1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
3. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent (20%) spare mounting space. All locks will be keyed identically.
4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
5. All outside mounted enclosures shall meet the NEMA-4 rating.
6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

E. Identification:

1. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
2. All field enclosures, other than controllers, shall be identified with a Bakelite nameplate. The lettering shall be in white against a black or blue background.
3. Junction box covers will be marked to indicate that they are a part of the BAS system.
4. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.
5. All I/O field devices inside FIP's shall be labeled.

F. Location:

1. The location of sensors is per mechanical and architectural drawings.
2. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.
3. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

G. Software Installation:

1. The Contractor shall provide all labor necessary to install, initialize, start-up, and debug all system software as described in this Section. This includes any operating system software or other third-party software necessary for successful operation of the system.

3.4 TRAINING

A. The BAS system supplier shall provide both on-site and classroom training to the Owner's representative and maintenance personnel per the following description:

1. On-site training shall consist of a minimum of 16 hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include:

a. System overview.
b. System software and operation.
c. System access.
d. Software features overview.
e. Changing setpoints and other attributes.
f. Scheduling.
g. Editing programmed variables.
h. Displaying color graphics.
i. Running reports.
j. Workstation maintenance.
k. Viewing application programming.
l. Operational sequences including start-up, shutdown, adjusting, and balancing.
m. Equipment maintenance.

2. Points identified in the point list and allow for setpoint changes as required by the Owner.

3.5 REPORTS

A. The Contractor will configure a minimum of four (4) reports for the Owner. These reports shall, at a minimum, be able to provide:

1. Trend comparison data.
2. Alarm status and prevalence information.
3. System user data.

3.6 POINT TO POINT CHECKOUT

A. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated, and approved by the Project Manager for submission to the Owner or Owner's representative.

3.7 CONTROLLER AND WORKSTATION CHECKOUT

A. A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the Owner or Owner's representative by the completion of the project.

3.8 DOCUMENTATION

A. As built software documentation will include the following:

1. Descriptive point lists.
2. Application program listing.
3. Application programs with comments.
4. Printouts of all reports.
5. Alarm list.
6. Printouts of all graphics.
7. Commissioning and System Startup.
8. An electronic copy of all databases, configuration files, or any type of files created specifically for each system.

END OF SECTION 230923

SECTION 230993 – SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED SECTIONS

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 sequences for HVAC systems, subsystems, and equipment.

B. Related Sections:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).

B. ATC: Automatic Temperature Control Contractor conducting work by and under this section.

C. Binary Output: On/off output signal or contact closure.

D. BMS: Building Management System.

E. BMCS: Building Management Control System.

F. BMS and FMS and BMCS are equivalent regarding definition and scope.

G. CO_2: Carbon Dioxide.

H. DDC: Direct digital control.

I. Digital Output: Data output that must be interpreted digitally.

J. DOAS: Dedicated Outside Air System.

K. RTU: Rooftop Unit.

L. VAV: Variable air volume.

M. VFD: Variable Frequency Drive.

N. VRF: Variable Refrigerant Flow.

1.4 GENERAL CONTROL SEQUENCES

A. Controls Contactor shall have a meeting with the Architect, Engineer, and Owner prior to programming to discuss capabilities, schedules, and sequences.

B. Contractor shall provide all required control devices, meters, hardware, and software to achieve the specified sequences of operation as outlined in these specifications and as detailed on Drawings whether indicated and/or implied. Refer to Drawings for general I/O points. All points may not be listed and are indicated for general description.

C. BMS shall monitor and report all control function alarm points.

D. System shall have capacity to store trend data for no less than one (1) year.

E. The BMS shall monitor all fans status via a current sensor. If anytime the fan is enabled and current is not sensed, an alarm shall be initiated at the BMS central computer and at the local panel.

F. **Pandemic Purge Mode**: BMS system will have a pandemic purge mode button on main graphics page. When button is activated, the following cycle will happen daily until purge mode is disabled via graphics:

1. Morning Purge:

   a. All supply and exhaust fans will run continuously for 1 hour (adj) prior to the start of scheduled occupancy.
   b. Air Handling systems and RTUs will run continuously during the daily one-hour (adj) pre-occupancy purge cycle.
   c. Temperature setpoints during purge cycle shall remain at unoccupied night setback setpoints.

2. Evening Purge:

   a. All supply and exhaust fans will run continuously for 1 hour (adj) after the end of scheduled occupancy.
   b. Air Handling systems will run continuously during the daily one-hour (adj) post-occupancy purge cycle.
   c. Temperature setpoints during purge cycle shall follow unoccupied night setback setpoints.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 DEDICATED ONE HUNDRED PERCENT (100%) OUTSIDE AIR SYSTEM

A. The DOAS Unit will be provided with factory installed packaged control. Unit manufacturer will provide BACnet controller, and all controls end devices to meet the sequence of operations detailed below. BMS contractor shall provide low voltage control wiring for field sensors provided by unit manufacturer.

B. BMS contractor will integrate DOAS unit into building-wide control system via BACnet.

C. Occupied Schedule: The unit will be scheduled to operate based on an Owner defined occupied/unoccupied schedule.

D. Adjustable Setpoints and Schedules: Unless otherwise indicated, setpoints listed in the sequence of operation shall be adjustable by the Owner through the BMS graphical interface. The Owner shall

also be able to easily adjust the occupied and unoccupied hours by individual unit or globally through a building wide schedule at the BMS graphical interface.

E. Occupied/Unoccupied Control: The unit will be indexed to operate based on an Owner defined occupied/unoccupied schedule within the BMS and communicated to the DOAS through BACnet. Unit will operate in the following modes: unoccupied, optimal start warm-up/cool-down, and occupied.

F. Unoccupied Mode: When the unit is indexed off, the supply and exhaust fans shall be off, the outside air and exhaust air dampers shall be closed, the energy wheel shall be off, and the heating and cooling shall be disabled.

G. Unoccupied Setback Mode: If during the unoccupied mode, a zone calls for additional heating (local radiation is 1st stage of heating), because a zone temperature has dropped below the setback setpoint, the BMS shall enable the DOAS and index the maximum supply air temperature setpoint to 85°F through BACnet. The packaged controller shall modulate the gas heating to satisfy the supply air setpoint. This shall continue, until the VRF call for heating ends.

H. Unoccupied Setup Mode: If during the unoccupied mode, a zone calls for setup cooling, because a zone temperature has risen above the setup setpoint, the BMS shall enable the DOAS and index the minimum supply air temperature setpoint to 55°F through BACnet. The packaged controller shall cycle/modulate the DX cooling to satisfy the supply air setpoint. This shall continue, until the call for cooling ends.

I. Optimal Start Warm-Up/Cool-Down: The DOAS shall be indexed to warm-up or cool-down modes based on a BMS optimal start program. Optimal start shall be based on outside air conditions and past inside building history. The BMS shall trend the outside air temperature with respect to the warm-up/cool-down times and shall optimize the starting time of the DOAS ahead of the scheduled occupied time to achieve the occupied setpoints based on the trended data.

J. Occupied Mode: The BMS shall index the unit to the occupied mode through BACnet and the unit shall operate as follows:

K. Supply Fan Control: When the BMS indexes the unit to operate, the packaged controls shall open the outside air damper and start the variable speed supply fan.

1. Supply Fan Starting Sequence begins by energizing relay G and setting the Supply Fan Speed Command to fifty percent (50%). The supply fan status switch (IFFS) closes, energizing relay IFFR. If after 2 minutes there is no proven signal, Diagnostic: Supply Fan Failure will be displayed, and the unit will shut down requiring a manual reset.

L. Exhaust Fan Control: When the unit is enabled to operate, the exhaust fan will also be indexed to start by the DOAS factory controller. After completing the Supply Fan Starting Sequence, Exhaust Damper Open Close Command is enabled. Once the Exhaust Damper End Switch has proven, Exhaust Fan Start Stop Command is enabled.

M. Discharge Air Temperature Control:

1. Cooling Mode:

a. Discharge Air Control:

1) Cooling Mode is enabled whenever the Outdoor Air Temperature Active rises above the Outdoor Air Cooling Enable Setpoint. The Outdoor Air Temperature Active must be above the Outdoor Air Heating Enable Setpoint. During Cooling

Mode, Cooling Capacity is adjusted to maintain Discharge Air Temperature Setpoint Active.

2. Cooling Mode: Enable DX Compressor (s) as required to maintain discharge air temperature setpoint 55°F (adj.).
3. Discharge Air Control and Multi-Zone VAV Control:

    a. Discharge Air Temperature Setpoint Active is controlled by Discharge Air Cooling Setpoint BAS during cooling operation, and Discharge Air Heating Setpoint BAS during heating. If Discharge Air Temperature Setpoint BAS is In Service, the program will use this over the discharge cooling and heating setpoints.

4. Heating Mode:

    a. Gas heat shall be modulated to maintain a constant 70°F (adj.) discharge air temperature.

N. Energy Wheel: Energy wheel shall be off during Unoccupied Mode. Energy Wheel shall run continuously at constant speed, subject to defrost control, during the Occupied Mode. If during the Occupied Mode, the unit enters Economizer Mode, the Energy Wheel shall be indexed off.

O. Energy Wheel Control: During the Unoccupied Mode, the Energy Wheel will remain off. In the Occupied Mode, with the supply fan in operation and the unit not in Economizer Mode, the wheel bypass damper shall be closed, and the Energy Wheel will run continuously at constant speed. If during the Occupied Mode the unit enters the Economizer Mode, the Energy Wheel will be indexed off and the bypass damper shall open.

P. Energy Recovery Wheel Operation (ERV):

1. The Energy Recovery Wheel Start Stop Command is enabled whenever there is a call for exhaust fan. During Ventilation Mode or Economizer Mode the ERV is disabled, except during the cleaning cycle, which occurs for 2 minutes every 30 minutes.
2. During cooling operation, the Energy Recovery Exhaust Air Bypass Position Command is locked at zero percent (0%) (closed position) for full energy recovery. During heating operation, the position is modulated to maintain the Discharge Air Temperature Setpoint Active for variable effectiveness capacity control. Once the bypass damper becomes fully closed, the primary heater will be engaged.
3. During Economizer Mode and Ventilation Mode the ERV bypass dampers are locked in the open position.

Q. Energy Wheel Without VFD: The unit prevents frost accumulation on the ERV by measuring the Exhaust Leaving Temperature Local. The Energy Recovery Outdoor Air Bypass Position Command is modulated open to maintain 15°F for the exhaust temperature. Above this temperature, the bypass damper will remain at zero percent (0%) signal (closed) when the ERV is in operation.

R. Enthalpy Economizer Control: The unit operates in one hundred percent (100%) outside air mode, there is not a true Economizer Mode with mixed air. If the outdoor conditions are suitable, the Economizer Mode shall consist of shutting down the Energy Wheel and open up the bypass damper (if equipped). If the outdoor enthalpy is less than the return air enthalpy, the unit Economizer Mode will be enabled. If outside air conditions are not suitable, the Energy Wheel operation will resume.

S. Space Humidity Control: During the Occupied Mode, the return air relative humidity will be monitored. Return air humidity shall be maintained below a setpoint of fifty percent (50%) RH (adj.). If the return air humidity rises above set point, the first compressor will be indexed on and

modulated to full capacity and then the hot gas will be modulated to maintain the discharge air temperature setpoint until return air humidity setpoint in satisfied. Additional DX cooling stages will be indexed on as needed to satisfy the return humidity setpoint.

T. Dehumidification Mode:

1. Discharge Air Control:

a. Dehumidification Mode is enabled whenever the Outdoor Air Dewpoint rises above the Outdoor Air Dewpoint Enable Setpoint. The Outdoor Air Temperature Active must be above Outdoor Air Heating Enable Setpoint. During Dehumidification Mode, Cooling Capacity is adjusted to maintain the Dehumidification Temperature Setpoint Active.

2. Space Control with Energy Recovery Wheel or has Mixed Air:

a. Dehumidification Mode is enabled whenever the Space Dewpoint rises above the Space Dewpoint Calculated Enable Setpoint. During Dehumidification Mode, Cooling Capacity is adjusted to maintain the Dehumidification Temperature Setpoint Active.

U. Hot Gas Reheat:

1. Hot Gas Reheat Valve Command (if installed) is enabled when unit is in dehumidification mode. Units with less than three (3) compressors and no modulating capacity (Standard scroll compressors) enable Hot Gas Reheat Command in cooling and dehumidification mode.
2. When enabled, Hot Gas Reheat Valve Command is adjusted to maintain Discharge Air Temperature Setpoint Active.
3. Units with less than three (3) compressors and no modulating capacity, reheat is utilized during Cooling Mode to maintain steady discharge air conditions and reduce compressor cycling.

V. Hot Gas Reheat Purge: Hot Gas Reheat Purge Mode is initiated if the Hot Gas Reheat Valve Command is between ten and fifty percent (10-50%) for 30 continuous minutes. During Hot Gas Reheat Purge Mode the signal first goes to eighty percent (80%) for 1 minute, then to ten percent (10%) for 1 minute. The Hot Gas Reheat Valve Command returns to its previous position and will begin to modulate after a 30-second delay.

W. Smoke Detection: The unit shall shut down and generate an alarm upon receiving a supply or return air smoke detector status.

X. Demand Control CO_2 Ventilation: Modulating dampers are required for CO_2 control. The unit will modulate the Outdoor Air Damper Position Command to maintain Space CO_2 Concentration Local to Space Concentration Setpoint. The CO_2 concentration can also be communicated to Space CO_2 Concentration BAS. The CO_2 Concentration sensor/signal must be field provided and installed.

Y. Supply /Exhaust Fan Control:

1. Occupied Mode: Supply fan and exhaust fan shall run continuously at a constant speed.
2. Unoccupied Mode: Supply fan and exhaust fan will be off.

Z. BACnet Monitoring Points: At a minimum, the BMS shall monitor the following I/O points through the unit's BACnet interface:

1. Supply Fan Status & Speed

2. Exhaust Fan Status & Speed
3. Compressor/Cooling Capacity
4. Gas Furnace Status & Capacity
5. Dehumidification Status & Hot-Gas Reheat Capacity
6. Energy Recovery Wheel Status
7. Filter Status
8. Heat/ Cool Mode Request
9. Supply Duct Static Pressure & Setpoint
10. Supply Air, Return Air & Outside Air Temperatures
11. Outside & Return Air Enthalpy
12. Return Air Relative Humidity
13. Leaving Coil/Entering Fan Temperature
14. Energy Wheel Exhaust Air Temperature
15. Energy Wheel Leaving Air Temperature (Supply)

AA. Alarms: The following items will generate alarms within the BMS:

1. Supply Air Temperature out of range.
2. Compare BMS and Factory supply air temp readings, alarm on relative discrepancy.
3. Compare BMS and Factory supply duct static pressure readings, alarm on relative discrepancy.
4. Smoke Shutdown Alarm.
5. Supply Fan Status Failure (through BACnet).
6. Exhaust Fan Status Failure (through BACnet).
7. Clogged Filter Status (through BACnet).
8. BACnet Diagnostic Alarms.

BB. Graphics: The following items will be displayed on the BMS graphics:

1. Complete System Graphic including temperature, humidity, pressure, airflow, setpoints, commands, and status.
2. Outside Temperature and Humidity.
3. Alarm conditions.
4. Occupied/Unoccupied mode.

3.2 VRF SYSTEM

A. The VRF system will be furnished with a BACNET interface to allow read/write capabilities through the BMS.

B. ESC shall provide a separate combination space temperature, humidity, and CO_2 sensors for each classroom/office.

C. The BMS shall enable, disable, set operating modes, and send setpoints to the VRF system controls via BACnet gateway communication interface. For the VRF system, enable indicates the unit is on and disable indicates the unit is off. The operating modes are heating mode, cooling mode, or fan mode. Setpoint temperatures will be defined by the occupied and unoccupied modes. The VRF zone temperature sensor shall control the indoor unit. Each zone will also have a BMS zone temperature sensor for VRF mode control.

D. Adjustable Setpoints and Schedules: Unless otherwise indicated, setpoints listed in the sequence of operation shall be adjustable by the Owner through the BMS graphical interface. The system shall operate based on a time-of-day occupied/unoccupied schedule within the BMS. The occupied/unoccupied schedule shall also be easily adjustable through the BMS graphical interface.

1. Note: The associated DOAS, which delivers fresh outdoor air to each VRF zone, shall be enabled to operate during the VRF occupied schedule.

E. Initial Setpoints: Initial space temperature setpoints shall be as follows:

Occupied	Unoccupied
Heating: 70°F	Heating: 60°F
Cooling: 75°F	Cooling: 82°F

F. Occupied Schedule: The units will be scheduled to operate based on an Owner defined occupied/unoccupied schedule.

G. Optimum Start/Stop: The BMS shall continuously compare the outdoor air temperature and warm-up/cool down history of each space and adjust the start time of the units to allow proper space conditions by the scheduled occupancy time. Schedule optimum start/stop for up to 2 hours prior to occupancy.

H. Warm-Up Mode: The BMS shall monitor space temperature. If the space temperature is less than 62 degrees F (adj.) and the system is in winter mode, the unit will start in the warm-up mode and run until the space temperature rises to 68 degrees F.

I. Cool-Down Mode: The BMS shall monitor space temperature. If the average space temperature is greater than 80 degrees F and the system is in summer mode, the unit will start in the cool down mode and run until the space temperature drops below 76 degrees.

J. Space Temperature Control: Space temperature setpoints shall be maintained based on whether the unit is in Winter/Summer Mode or Occupied/Unoccupied Mode.

1. Occupied Winter Setpoint: 70 degrees F.
2. Unoccupied Winter Setpoint: 55 degrees F.
3. Occupied Summer Setpoint: 75 degrees F.
4. Unoccupied Summer Setpoint: 85 degrees F.

K. Condensate overflow switch shall shut-down unit and alarm BMS.

1. Condensate Overflow Shutdown: The BMS shall provide and install condensate pan sensor for all VRF ducted units and generate an alarm at the BMS.

L. BMS contractor shall provide separate controller to monitor Space CO_2, Space Humidity, and condensate overflow alarm.

M. Additional VRF System Monitoring: Through the BACnet gateway interface, the BMS shall read available interface points from the VRF control system including, but not limited to the following:

1. On/Off Status.
2. Operating Mode Status.
3. Error Code.
4. Filter Status.
5. Space Temperature.
6. Temperature Setpoints.

N. Alarms: The following items will generate alarms within the BMS:

1. High Space Temperature (5°F from setpoint with 15-minute delay).

2. Low Space Temperature (5°F from setpoint with 15-minute delay).
3. Condensate High Level Condition.

O. Graphics: The following items will be displayed on the BMS graphics:

1. System Graphic per VRF Zone.
2. Alarm conditions.
3. Occupied/Unoccupied Mode.
4. Space temperature and setpoints.
5. VRF interfaced control points.
6. Space Humidity %.
7. Space CO_2 PPM.

3.3 EXHAUST FANS

A. Exhaust fans shall be enabled by BMS during Occupied Mode. BMS to monitor status.

B. Custodial/Janitor Closet exhaust fans shall be enabled by BMS during Occupied Mode. BMS to monitor status.

C. Fan Failure Alarm: The BMS shall monitor the fan status. A fan failure alarm will be generated if the fan command does not match the fan status after a 2-minute delay upon change of command state.

D. Alarms: The following items will generate alarms within the BMS:

1. Fan Failure Alarm.

E. Graphics: The following items will be displayed on the BMS graphics:

1. System Graphic.
2. Alarm conditions.
3. Exhaust Fan Command.
4. Exhaust Fan Status.

END OF SECTION 230993

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

B. Line Test Pressure for Refrigerant R-407C:

1. Suction Lines for Air-Conditioning Applications: 230 psig.
2. Suction Lines for Heat-Pump Applications: 380 psig.
3. Hot-Gas and Liquid Lines: 380 psig.

C. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: ¼-inch equals 1 foot.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.8 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum ¾-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.

2. Diaphragm: Phosphor bronze and stainless-steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F (135 deg C).

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F (135 deg C).

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless-steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F (135 deg C).

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless-steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with ½-inch (16-GRC) conduit adapter, and appropriate electrical characteristics.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F (116 deg C).
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless-steel.

3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F (116 deg C).

G. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless-steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F (4.4 deg C).
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless-steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless-steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with ½-inch (16-GRC) conduit adapter, and 24-V ac coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F (116 deg C).

I. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F (135 deg C).

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F (116 deg C).

K. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F (116 deg C).

L. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F (135 deg C).

M. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F (135 deg C).

N. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F (135 deg C).

2.3 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants
4. INEOS Fluor Americas LLC

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

D. Install a full-sized, three-valve bypass around filter dryers.

E. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

F. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two (2) bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

G. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

J. Install filter dryers in liquid line between compressor and thermostatic expansion valve and in the suction line at the compressor.

K. Install receivers sized to accommodate pump-down charge.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Sections 230923” Direct Digital Control (DDC) System for HVAC Controls” and 230993 “Sequence of Operations for HVAC Controls” for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

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

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

D. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting.

F. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Double-wall round ducts and fittings.
4. Sheet metal materials.
5. Duct lagging material.
6. Sealants and gaskets.
7. Hangers and supports.
8. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

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

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.

4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
13. Preparation for selecting hangers and supports and seismic restraints.

C. Coordination Drawings: Plans, drawn to ¼-inch scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.

D. Welding certificates.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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

a. Lindab Inc.
b. McGill AirFlow LLC
c. SEMCO Incorporated
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL SPIRAL ROUND DUCTS AND FITTINGS

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

1. Lindab Inc.
2. McGill AirFlow LLC
3. SEMCO Incorporated
4. Sheet Metal Connectors, Inc.

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Inner Duct: Minimum 0.028-inch solid sheet steel.

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.13 Btu x in./h x sq. ft. x deg F at 75 deg F (24 deg C) mean temperature.
2. Insulation Thickness: 2 inches.
3. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
4. Coat insulation with antimicrobial coating.
5. Cover insulation with polyester film complying with UL 181, Class 1.

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008, with oiled, matte finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

E. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, ¼-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.5 DUCT LAGGING MATERIAL

A. General: Flexible barrier material for wrapping ducts to lower break-out noise from turbulent air.

B. Nominal Density: 1 lb./sq. ft.

C. Thickness: 0.10-inch.

D. The barrier is barium loaded high mass, limp vinyl bonded to a reinforced aluminum foil facing one (1) side, Under Industries **Model DL-10-LAG** or equivalent.

E. Sound Transmission Loss: dB

Hz	125	250	500	1000	2000	4000	STC
dB	15	19	21	29	33	37	27

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless-steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum sixty-five percent (65%).
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless-steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.

3. Solvent: Toluene and heptane.
4. Solids Content: Minimum sixty percent (60%).
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

H. Dissimilar Duct Metals:

1. EPDM O-ring and gaskets are to be used for dissimilar duct material.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.8 SEISMIC-RESTRAINT DEVICES

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

1. Cooper B-Line, Inc.; a division of Cooper Industries
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control
5. Loos & Co.; Cableware Division
6. Mason Industries
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; Tyco International, Ltd.

B. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

C. Restraint Cables ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

A. All ductwork shall be galvanized steel except as follows:

1. Toilet Area: Aluminum.
2. Automotive: Double wall spiral.
3. Shower Room: Aluminum.
4. Weight Room: Double wall spiral.
5. Kitchen Hood Exhaust: Engineered exhaust system.
6. Kiln Exhaust: Stainless-steel.
7. Clothes Dryer Exhaust: Aluminum duct with semi-rigid, UL listed, dryer to vent exhaust hose.
8. Therapy Pool: Aluminum.
9. Janitors Closet: Aluminum.
10. Dishwasher Exhaust: Aluminum.

3.2 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1-inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four (4) sides by at least 1½ inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

M. Install acoustic lagging material where indicated on plans.

3.3 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless-steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.4 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.7 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one (1) coat of flat, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections. Color as selected by Architect and Owner from manufacturer’s entire range.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

a. Supply Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than fifty percent (50%) of total installed duct area for each designated pressure class.
b. Return Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than fifty percent (50%) of total installed duct area for each designated pressure class.
c. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than fifty percent (50%) of total installed duct area for each designated pressure class.
d. Outdoor Air Ducts with a Pressure Class of 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than fifty percent (50%) of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven (7) days' advance notice for testing.

3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units:

a. Pressure Class: Positive 1-inch wg.

2. Ducts Connected to Constant-Volume Air-Handling Units:

a. Pressure Class: Positive 3-inch wg.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units:

a. Pressure Class: Positive or negative 1-inch wg.

2. Ducts Connected to Air-Handling Units Pressure Class: Positive or negative 3-inch wg.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2-inch wg.

2. Ducts Connected to dust collection system:

a. Pressure Class: Negative 8-inch wg.

3. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:

a. Type 304 stainless-steel sheet.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 3-inch wg.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Aluminum Ducts: Aluminum.

G. Liner:

1. Supply Air Ducts Within the Building Envelop: Fibrous glass, Type I, 2 inches thick.
2. Return Air Ducts Within the Building Envelop: Fibrous glass, Type I, 2 inches thick.
3. Transfer Ducts: Fibrous glass, Type I, 2 inches thick.
4. Supply Air Ducts Outside of The Building Envelop: Fibrous glass, Type I, 3 inches thick.
5. Return Air Ducts Outside of The Building Envelop: Fibrous glass, Type I, 3 inches thick.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two (2) vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two (2) vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two (2) vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three (3) segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four (4) segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five (5) segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Ceiling dampers.
6. Smoke dampers.
7. Combination fire and smoke dampers.
8. Flange connectors.
9. Turning vanes.
10. Remote damper operators.
11. Duct-mounted access doors.
12. Flexible connectors.
13. Flexible ducts.
14. Duct accessory hardware.

B. Related Requirements:

1. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

e. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to ten percent (10%) of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" latest edition for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with International Mechanical Code and Connecticut State Mechanical Code.

2.2 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" latest edition for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized or galvannealed.

C. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Material shall match components, minimum 3/8-inch.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

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

1. Greenheck Fan Corporation
2. Nailor Industries Inc.
3. Pottorff
4. Ruskin Company

B. Description: Gravity balanced.

C. Maximum Air Velocity: 1000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: Hat-shaped, 0.063-inch-thick extruded aluminum, with welded corners or mechanically attached and mounting flange.

F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:

1. Material: Aluminum.
2. Diameter: 0.20-inch.

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.

a. Sleeve Thickness: 20-gage minimum.
b. Sleeve Length: 6 inches minimum.

6. Screen Material: Aluminum.

7. Screen Type: Insect.
8. 90-degree stops.

2.4 BAROMETRIC RELIEF DAMPERS

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

1. Greenheck Fan Corporation
2. Nailor Industries Inc.
3. Pottorff
4. Ruskin Company

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 1000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: Hat-shaped, 0.063-inch-thick extruded aluminum, with welded corners or mechanically attached and mounting flange.

F. Blades:

1. Multiple, 0.050-inch-thick aluminum sheet.
2. Maximum Width: 6 inches.
3. Action: Parallel.
4. Balance: Gravity.

G. Blade Seals: Neoprene.

H. Blade Axles: Nonferrous metal.

I. Tie Bars and Brackets:

1. Material: Aluminum.
2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Synthetic, stainless steel or bronze.

L. Accessories:

1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.
3. Screen Mounting: Front mounted in sleeve.

    a. Sleeve Thickness: 20-gage minimum.
    b. Sleeve Length: 6 inches minimum.

4. Screen Material: Aluminum.
5. Screen Type: Insect.

2.5 MANUAL VOLUME DAMPERS

A. Single Blade Dampers. Maximum width of single blade shall be 14 inches, use opposed blade damper for height exceeding 14 inches. Pre-manufactured dampers shall be part of an assembly complete with damper, frame, axle, and bearings. The damper frame shall be installed internal to the duct and fastened with the appropriate hardware. The installation shall not interfere with the operation of the damper blade(s).

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

1. Rectangular:

a. Air Balance; **AC-111**
b. Greenheck; **MBD-10**
c. Ruskin; **MD25**

2. Round:

a. Air Balance; **AC-112**
b. Greenheck; **MBDR50**
c. Ruskin; **MDRS25**

C. Multiple Blade Dampers. Opposed blade damper shall be used where duct height exceeds 14 inches. Approved products for pre-manufactured devices are as follows:

1. Opposed Blade:

a. Air Balance; **AC-2**
b. Greenheck; **MBD-15**
c. Ruskin; **MD35OB**

D. Steel, Manual Volume Dampers: Except for outdoor air.

1. Linkage outside airstream.
2. Suitable for horizontal or vertical applications.
3. Frames:

a. Hat shaped.
b. Galvanized-steel channels, 0.064-inch-thick.
c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

a. Parallel- or opposed-blade design.
b. Stiffen damper blades for stability.
c. Galvanized, roll-formed steel, 0.064-inch-thick.

5. Blade Axles: Galvanized steel.
6. Bearings:

a. Oil-impregnated bronze.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Jamb Seals: Cambered aluminum.
8. Tie Bars and Brackets: Aluminum.
9. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.
    b. Include standoffs for insulated ductwork.

E. Aluminum, Manual Volume Dampers: For outdoor air.

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

    a. McGill AirFlow LLC
    b. Pottorff; a division of PCI Industries, Inc.
    c. Ruskin Company

2. Linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:

    a. Parallel- or opposed-blade design.
    b. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
    c. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.

6. Blade Axles: Galvanized steel.
7. Bearings:

    a. Oil-impregnated bronze.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Jamb Seals: Cambered aluminum.
9. Tie Bars and Brackets: Aluminum.
10. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.
    b. Include standoffs for insulated ductwork.

F. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

G. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a ¾-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.

H. All dampers shall be furnished with an elevated platform/standoff for insulated duct mounting.

I. Provide dampers in all branch ducts and duct splits whether indicated or not on the Drawings.

2.6 FIRE DAMPERS

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

1. Greenheck Fan Corporation **DFD-211/DFDR-511, DFD-231/DFDR-531**
2. Nailor Industries Inc.
3. Ruskin Company **DIBDX, IBDT, DIBDXGA**

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1½ and 3 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.39-inch-thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.

K. Grille Access Fire Dampers shall be provided where sidewall grilles are mounted to a fire rated wall.

L. Provide dampers; as required by all local and state codes; in ducts whether indicated or not on the drawings.

2.7 CEILING DAMPERS

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

1. Greenheck Fan Corporation
2. Nailor Industries, Inc.
3. Price
4. Ruskin Company
5. Titus

B. General Requirements:

1. Labeled according to UL 555C by an NRTL.
2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

F. Fire Rating: 2 or 3 hours as required to maintain fire rating.

2.8 SMOKE DAMPERS

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

1. Greenheck Fan Corporation **SMD-201/SMDR-501**
2. Nailor Industries Inc.
3. Ruskin Company **SD-60/SDRS25**

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Provided by Division 28, installed by Division 23 and wired by Division 26.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.

I. Damper Motors: Modulating or two-position action.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC Controls."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Non-Spring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

K. Grille Access Smoke dampers shall be provided where sidewall grilles are mounted to a smoke rated wall.

L. Accessories:

1. Auxiliary switches for signaling.
2. Test and reset switches, remote mounted.

M. Provide dampers; as required by all local and state codes; in ducts whether indicated or not on the drawings.

2.9 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Greenheck Fan Corporation; **FSD33 w/TOR**
2. Nailor Industries Inc.
3. Ruskin Company; **FSD60 w/TS-150**, **FSD60FA w/TS-150**
4. Air Balance Inc.; **FA1 w/Sens-O-Therm**

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1½ hours.

E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

G. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

H. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Leakage: Class I.

J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

L. Master control panel for use in dynamic smoke-management systems.

M. Damper Motors: Modulating or two-position action.

N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Division 26 Sections.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Non-Spring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

O. Grille access fire/smoke dampers shall be provided where sidewall grilles are mounted to a smoke rated wall.

P. Accessories:

1. Auxiliary switches for signaling.
2. Test and reset switches, damper mounted.

Q. Provide dampers; as required by all local and state codes; in ducts whether indicated or not on the drawings.

2.10 CORRIDOR DAMPERS

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

1. Greenheck Fan Corporation
2. Nailor Industries Inc.
3. Ruskin Company

B. General Requirements: Label combination fire and smoke dampers according to UL 555 for 1½-hour rating by an NRTL.

C. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

D. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.

E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

G. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application.

H. Damper Motors: Two-position action.

I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC".
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Non-Spring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

2.11 FLANGE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.12 TURNING VANES

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufacturers Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows" unless otherwise noted.

D. Vane Construction: Turning vanes shall be double wall construction of minimum 24-gauge galvanized metal. Each vane shall be securely riveted or welded to minimum 22-gauge runner or directly to duct.

E. Turning vanes shall have 2 inch inside radius spaced 2-1/8 inches apart through 24-inch-wide duct. Vanes in elbows larger than 24 inches shall have a 4½-inch-radius and be spaced 3¼ inches apart.

F. Vanes shall be installed in sections to reduce unsupported length for duct depths exceeding 60 inches.

2.13 REMOTE DAMPER OPERATORS

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

1. DuroDyne
2. Metropolitan Air
3. Young Regulator

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless-steel.

E. Cable operated dampers (COD) shall be provided where indicated on plans, and/or where required due to damper location above/behind finished construction, where access to damper would require access door in finished construction.

F. Provide cable operated dampers in branch duct serving diffusers in inaccessible ceiling locations whether indicated or not on the Drawings.

G. Cable shall terminate within the face of each diffuser/register/grille. Damper shall be adjustable through the face of the diffuser/register/grille with standard tools.

H. Furnish all required duct penetration seal plates, gaskets, bearings, retainers, and cable to duct mounting clamps.

I. Cable lengths shall be coordinated to allow damper to be placed at the branch duct take-off immediately off the main. Dampers shall be located as far as possible from the terminal outlet/diffuser.

J. Wall-Box Mounting: Recessed.

K. Wall-Box Cover-Plate Material: Steel.

2.14 DUCT-MOUNTED ACCESS DOORS

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

1. Ductmate Industries, Inc.
2. Greenheck Fan Corporation
3. McGill AirFlow LLC

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct" unless otherwise noted.

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Hinges: 1-by-1-inch butt or piano hinge and latches.
d. Latches: Similar to Ventfabrics, Inc. **No. 100** for small doors and **No. 310** where physical access is possible. Window latch/sash type hardware is specifically prohibited except where the door swing for a hinged door is restricted by the hung ceiling or some other obstruction.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two (2) latches.
b. Access Doors up to 18 Inches Square: Two (2) hinges and two (2) latches.
c. Access Doors up to 24 by 48 Inches: Three (3) hinges and two (2) latches with outside and inside handles.
d. Access Doors Larger Than 24 by 48 Inches: Four (4) hinges and two (2) latches with outside and inside handles.

4. Access doors shall be rated to maintain the fire/smoke rating of the equipment/duct in which they are installed.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Single wall with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0- to 8.0-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.15 DUCT ACCESS PANEL ASSEMBLIES

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

1. Ductmate Industries, Inc.
2. Flame Gard, Inc.
3. 3M

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.16 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5¾ inches wide attached to 2 strips of 2¾-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.

1. Minimum Weight: 16 oz./sq. yd.
2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than eighty percent (80%) of the compressed height of the spring at rated load.
3. Minimum Additional Travel: Fifty percent (50%) of the required deflection at rated load.
4. Lateral Stiffness: More than eighty percent (80%) of rated vertical stiffness.
5. Overload Capacity: Support two hundred percent (200%) of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of ¼-inch movement at start and stop.

2.17 FLEXIBLE DUCTS

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

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel strap in sizes 3 through 18 inches to suit duct size.

D. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.

2.18 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install motorized dampers at the discharge of exhaust fans or exhaust ducts as close as possible to the exhaust outlet unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Provide volume dampers in each branch duct serving diffuser whether indicated or not.

G. Install test holes at fan inlets and outlets and elsewhere as indicated and as required.

H. Install fire and smoke dampers according to UL listing.

I. Install duct security bars. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints and ½-inch-diameter steel bars, 6 inches o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2½-by-2½-by-¼-inch steel angle to four (4) sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.

J. Connect ducts to duct silencers rigidly.

K. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream and downstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

L. Install access doors with swing against duct static pressure.

M. Access Door Sizes:

1. One-Hand or Inspection Access: 12 by 12 inches.
2. Two-Hand Access: 12 by 12 inches.
3. Head and Hand Access: 20 by 16 inches.

4. Head and Shoulders Access: 24 by 24 inches.
5. Body Access: 24 by 24 inches.
6. Body plus Ladder Access: 24 by 24 inches.

N. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

O. Locate all duct balancing dampers above accessible ceilings, or provide cable operated dampers.

P. Install flexible connectors to connect ducts to equipment.

Q. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

R. Install duct test holes where required for testing and balancing purposes.

S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of ¼-inch movement during start and stop of fans.

3.2 FLEXIBLE DUCT

A. Flexible duct sections shall not exceed 4 feet fully extended.

B. Flexible ductwork shall not be used for offsets or elbows.

C. Joints shall be made with a minimum 2-inch overlap lined with **EC800** mastic and sealed with metal clamps.

D. Flexible ductwork shall only be used for branch duct to diffuser connections when indicated as an acceptable connector on the mechanical drawing details.

E. Connections from branch duct to diffuser necks shall be rigid sheet metal unless otherwise noted on the drawing details.

F. Flexible ductwork shall be supported in accordance with SMACNA Figure 3-10 and 3-11 “Flexible Duct Supports”. A minimum of two (2) 1-inch-wide metal straps shall be used. Wire hanging is not acceptable.

3.3 TEST CONNECTIONS

A. On the discharge duct from each air handling unit downstream at least 5 feet from unit if duct is accessible, or closer to unit if necessary, install a #**699** Ventlock instrument test hold device for balancing and testing of system.

3.4 ACCESS DOORS IN WALLS AND CEILINGS

A. At each control and balancing damper in ductwork, at each fire damper and volume box, when located above ceiling or inside the wall not accessible by removal of grille or from the airshafts, furnish an access door for installation by the Contractor. Access doors shall be 18 inches x 18 inches (minimum) unless otherwise indicated on plans. In plenum ceilings, provide felt between the door and frame to make an airtight seal.

B. All access panel locations shall be shown on the Coordination Drawings.

C. Access doors shall be rated to maintain the fire/smoke rating of the wall/ceiling/construction in which they are installed.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulated flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For flexible ducts.

1. Include plans showing locations and mounting and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

A. Products provided exclusively by one (1) of the following manufacturers:

1. Buckley Associates
2. Hart and Cooley
3. Johns Manville

B. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: R6.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches to suit duct size.

B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect diffusers to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

D. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.

E. Install duct test holes where required for testing and balancing purposes.

F. Installation:

1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.

G. Supporting Flexible Ducts:

1. Suspend flexible ducts with bands 1½ inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed ½-inch per 12 inches.
2. Install extra supports at bends placed approximately one (1) duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.

END OF SECTION 233346

SECTION 233423 - HVAC POWER VENTILATORS

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. Ceiling-mounted ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

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

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustical tile.
3. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

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

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of equipment supports with actual equipment provided.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTED VENTILATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Greenheck or comparable product by one (1) of the following:

1. Acme Engineering & Manufacturing Corporation
2. Loren Cook Company

B. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.

C. Housing: Steel, lined with acoustical insulation.

D. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

E. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

F. Motors:

1. Motor enclosures shall be open drip proof (ODP), opening in the frame body and or end brackets.
2. Motors are permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase.
3. Motors shall be mounted on vibration isolators and be accessible for maintenance.
4. Compatible for use with speed controls
5. Thermal overload protection

G. Grille: Aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

H. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

I. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from one hundred percent (100%) to less than fifty percent (<50%).
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Aluminum backdraft damper.
9. Wall louver discharge.
10. Disconnect Switches:

    a. NEMA Rated: 1.
    b. Positive electrical shut-off.
    c. Access for wiring shall be external.

J. Capacities and Characteristics:

1. Refer to Schedules on Drawings.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using spring isolators having a static deflection of 1-inch. Vibration- and seismic-control devices are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

1. Instructor shall be factory trained and certified.
2. Provide not less than two hours of training.
3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
4. Obtain Owner sign-off that training is complete.
5. Owner training shall be held at Project site.

B. Provide video recordings of how the HVAC system equipment physically operates, etc.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Ceiling Diffusers:

a. Rectangular and square ceiling diffusers.

2. Registers and Grilles:

a. Adjustable registers.
b. Fixed face grilles.

B. Related Sections:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

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

    a. Kruger
    b. Price Industries
    c. Titus

2. Devices shall be specifically designed for variable-air-volume flows.
3. Characteristics and Performance:

    a. Refer to Schedules on Drawings.
    b. Material: Aluminum.
    c. Finish: Baked enamel. Color to be selected by Architect and Owner from manufacturer's entire range.
    d. Face Size: See Schedule on Drawings.
    e. Mounting: Surface and T-bar: See Schedule on Drawings and refer to Architectural RCP Drawing.
    f. Pattern: Adjustable.

2.2 REGISTERS AND GRILLES

A. Adjustable Register:

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

    a. Kruger
    b. Price Industries
    c. Titus

2. Devices shall be specifically designed for variable-air-volume flows.
3. Characteristics and Performance:

    a. Refer to Schedules on Drawings.
    b. Material: Steel.
    c. Finish: Baked enamel. Color to be selected by Architect and Owner from manufacturer's entire range.
    d. Face Blade Arrangement: Vertical spaced ¾-inch apart.
    e. Individually adjustable double deflection.
    f. Core Construction: Integral.
    g. Rear-Blade Arrangement: Horizontal spaced ¾-inch apart.
    h. Frame: 1.25-inch-wide.
    i. Mounting: Countersunk screw.

B. Fixed Face Grille:

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

    a. Kruger
    b. Price Industries
    c. Titus

2. Characteristics and Performance:

    a. Refer to Schedules on Drawings.
    b. Material: Steel.
    c. Finish: Baked enamel. Color to be selected by Architect and Owner from manufacturer's entire range.
    d. Face Blade Arrangement: Horizontal spaced ¾ inch apart.
    e. Blade Deflection Angle: 35 degrees.
    f. Frame: 1¼ inches wide.
    g. Mounting: Countersunk screw and lay-in. See Schedule on Drawings.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes factory-assembled, dedicated outdoor air-handling units, including multiple components, capable of heating and cooling one hundred percent (100%) outdoor air.

1.3 DEFINITIONS:

A. ECM: Electronically commutated motor.

B. ISCOP: Integrated Seasonal Coefficient of Performance.

C. ISMRE: Integrated Seasonal Moisture Removal Efficiency.

D. MRC: Moisture Removal Capacity.

E. MRE: Moisture Removal Efficiency.

1.4 ACTION SUBMITTALS

A. Product Data: For each dedicated outdoor-air unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories.
    d. Motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include heat exchangers with performance characteristics.
9. Include dampers, including housings, linkages, and operators.

B. Delegated-Design Submittal: For Roof Mounted Air Handling Unit supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Wind and Seismic Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

C. Shop Drawings: For each dedicated outdoor-air unit.

D. Shop Drawings:

1. Unit manufacturer shall provide the following information with each shop drawing/product data submission:

   a. Dimensioned arrangement drawings for each roof mounted air handling unit including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation, and service clearances.
   b. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
   c. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.
   d. All performance data, including capacities and airside and waterside pressure drops, for components.
   e. Fans:

      1) Certified fan-performance curves with system operating conditions indicated.
      2) Certified fan-sound power ratings.
      3) Fan construction and accessories.
      4) Motor ratings, electrical characteristics, and motor accessories.

   f. Certified coil-performance ratings with system operating conditions indicated.
   g. Dampers, including housings, linkages, and operators.
   h. Filters with performance characteristics.
   i. Sound data shall be provided using ARI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor/roof plans and other details, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates, for dedicated outdoor-air units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

4. Restraint of internal components.

C. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control reports.

E. Startup service reports.

F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dedicated outdoor-air units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One (1) set for each dedicated outdoor air unit.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units from physical damage. Leave factory shipping covers in place until installation.

C. Units to be secured via base rail tie-down locations.

1.9 WARRANTY

A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period.

1. Provide parts warranty extending either twelve (12) months from date of unit start-up or a maximum of eighteen (18) months from unit ship date.
2. Provide 25-year heat exchanger limited warranty.
3. Provide 5-year compressor limited warranty.

1.10 REGULATORY REQUIREMENTS

A. Unit shall conform to the appropriate standards listed in Section 103 as well as be listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for compliance with the following applicable standards.

1. Standard for Safety Heating and Cooling Equipment-Fourth Edition, UL 1995/CSA C22.2#236 Issue: 2011/10/14.
2. Standard for Gas Unit Heaters and Gas-Fired Duct Furnaces ANSI Z83.8-2013, CSA 2.6-2013, Third Edition – 2006 (indirect gas-fired/e).
3. Standard for Non-Recirculating Direct Gas-Fired Industrial Air Heaters, ANSI Z83.4 / CSA 3.7 - Issued: 2013/03/01 Ed: 3.
4. In the event the unit is not approved by an NRTL for compliance with the appropriate standards, the manufacturer shall, at manufacturer's expense, provide for a field certification and labeling of unit by an NRTL to the appropriate standards. Manufacturer shall, at manufacturer's cost, complete any and all modifications required by NRTL prior to certification and field labeling. Manufacturer shall include coverage of all modifications in unit warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design: Trane; **Horizon™ Model OAU** (Packaged Outdoor Air Unit)

1. Manufacturer shall comply with all specifications, performance requirements listed herein, dimensional requirements, service, start-up, and warranties. Subject to compliance with requirements, equals shall meet or exceed all scheduled values.
2. Unit manufacturer to provide MRE and MRC efficiency values as established by AHRI 920.
3. One hundred percent (100%) outdoor air units must be capable of providing DX Coil leaving air temperature of 50° F, or lower, at the specified airflows, at 60 F ambient temperature, while providing 20 degree reheat for discharge condition of 70 F dry bulb/50 F dew point.

B. Approved Manufacturers:

1. Desert Aire
2. Munters

2.2 GENERAL UNIT DESCRIPTION

A. Units furnished and installed shall be packaged outdoor air units as scheduled on contract documents and described in these specifications. Units shall be designed for dehumidification, cooling and/or heating of one hundred percent (100%) outdoor air. For dehumidification and cooling modes, the evaporator temperature shall be monitored, reported at unit controller. Compressor controls shall modulate capacity to maintain evaporator leaving set point. Hot gas bypass shall not be used to control compressor capacity. Compressor Hot Gas Reheat (HGRH) shall be factory installed. To prevent rehydration of evaporator condensate, the reheat coil face shall be located a minimum of 6 inches downstream from the leaving face of the evaporator coil. Heating system shall include modulating controls. Compressor on-off only or primary heating on-off only controls shall not be acceptable control strategies.

B. Units shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.

C. Unit discharge airflow configuration shall be:

1. Vertical discharge through unit base or horizontal discharge through side of unit.

2.3 CABINET

A. Cabinet Panels: 2-inch double-wall foamed panel construction throughout the indoor section of unit to provide nonporous, cleanable interior surfaces. All interior seams exposed to airflow shall be sealed. All interior surfaces exposed to airflow shall be 2-inch double wall including the floor and ceiling.

B. Insulation: 2-inch double-wall foamed injected R-13 construction throughout. Unit shall be double wall in all areas in contact with supply and exhaust air streams.

C. Cabinet base shall be double wall construction designed to prevent trapping or ponding of water within the unit base. Cabinet base pan shall be insulated with 2-inch-thick polyisocyanurate foam. Foam insulation shall be fully enclosed with galvanized steel insulation cover. Insulation shall not be applied to underside of unit base.

D. Cabinet Base Rails: Side and end base rails shall include openings for forklift and tie-down access. To protect unit base from fork damage side rails shall include removable heavy gauge fork pockets.

E. Shipping anchors attach to and/or through unit base rails. Straps over unit shall not be used to secure unit for shipping.

F. Cabinet material interior and base rails: shall be G-90 zinc-coated galvanized steel. Material gauge shall be a minimum of 14-gauge for base rails, 16-gauge for structural members, and 20-gauge for access doors and cabinet panels.

G. Exterior Corrosion Protection: Exterior cabinet panels shall be a base coat of G-90 galvanized steel with both exterior and interior surfaces cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be in compliance with ASTM B 45 salt spray testing at a minimum of 672-hour duration.

H. Cabinet construction shall provide hinged panels providing easy access for all parts requiring routine service.

I. Cabinet top cover shall be one-piece construction or where seams exist, it shall be double-hemmed and gasket-sealed.

J. Hinged Access Panels: Water- and air-tight hinged access panels shall provide access to all areas requiring routine service including air filters, heating section, electrical and control cabinet sections, optional ERV and power exhaust fan section, supply air fan section, evaporator, and reheat coil sections. Insulated doors shall be constructed to allow the hinges to be reversed in the field.

1. Hold-open devices shall be factory installed on all hinged access doors. Chains shall not be used as hold-open devices.
2. Latches with locking hasp or tool operated closure devices shall be factory installed on all hinged access panels.

K. Drain Pan material shall be Type 430 stainless-steel drain and constructed to sloped in two (2) directions to ensure positive drainage with corners exposed to standing water and drain fittings welded liquid tight to prevent leaks. Pan shall have a minimum depth of 2 inches. Base of drain pan shall be insulated with 1-inch-thick foam insulation.

L. Provide openings either on side of unit or through the base for power, control, and gas connections.

M. Unit shall be equipped with a 6-inch filter rack upstream of the evaporator. Frame shall be field-adjustable to match any filter combination specified in the following section.

N. Factory assembled inlet hood with 2-inch mist eliminators for OAD units.

O. Factory assembled inlet hood with bird screen for OAB units.

2.4 FANS AND MOTORS

A. Provide factory mounted variable frequency drive for supply and exhaust fans.

B. Indoor fans shall be high efficiency backward curved impeller.

C. The indoor fan motor shall be an electronic commutated motor with integrated power electronics for variable motor speed.

D. Outdoor fans shall be direct drive with premium efficiency motors, statically and dynamically balanced, draw through in the vertical discharge position.

E. Provide shafts constructed of solid hot rolled steel, ground and polished, with keyway, and protectively coated with lubricating oil.

2.5 AIR FILTERS

A. Evaporator Inlet:

1. 2-inch-deep pleated MERV 8.
2. 2-inch-deep pleated MERV 13.

B. Energy Recovery Wheel:

1. 2-inch-deep pleated MERV 8.

2.6 DAMPERS

A. Unit shall include a motor operated outdoor air damper constructed of galvanized steel.

B. Damper blades shall be air foil design with rubber edge seals designed not to exceed a 4 cfm/sq. ft. leakage rate exceeding ASHRAE 90.1 damper leakage requirements.

C. Damper actuator shall be factory mounted and wired sealed spring return and either two-position or fully modulating.

D. Dampers air velocity shall not exceed 2000 fpm.

E. Return air damper shall be of same material, construction, and leakage rate as outdoor air damper. Return air damper actuator shall be factory mounted and wired sealed spring fully modulating and operate based on outdoor air damper feedback signal to properly regulate RA airflow.

2.7 DEHUMIDIFICATION/COOLING

A. Compressors:

1. All units shall have digital scroll compressors.

2. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus ten percent (+/-10%) of unit nameplate voltage.
3. Internal overloads shall be provided with the scroll compressors.
4. Each compressor shall have a crankcase heater to minimize the amount of liquid refrigerant present in the oil sump during off cycles.
5. Each compressor shall be mounted on rubber vibration isolators, to reduce the transmission of noise.
6. Provide each unit with one (1) or two (2) hermetically sealed refrigerant circuit(s) factory-supplied completely piped with liquid line filter-drier, liquid line charging port, suction and liquid line pressure ports, sight glass, and thermal expansion valve.
7. Provide each circuit with automatic reset high and low pressure and high temperature switches for safety control.

B. Coils:

1. Evaporator, condenser, and hot gas reheat coils shall be constructed with copper tubes mechanically bonded to configured aluminum plate fins.
2. Coils shall be factory leak tested in accordance ANSI/ASHRAE 15-1992 at a minimum pressure of 500 psig.
3. The condenser coil shall have a fin designed for ease of cleaning.
4. Evaporator coil shall include six (6) or four (4) rows, as scheduled, of cooling interlaced for superior sensible and latent cooling with a maximum of 12 FPI for ease of cleaning.
5. Reheat coil shall be fully integrated into the supply airstream and be capable of delivering design supply air temperature.
6. To prevent re-hydration of condensate from evaporator coil, the evaporator coil face and the hot gas reheat coil face shall be separated by a minimum of 6 inches.

C. Condenser Section:

1. Outdoor Fans: Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets.
2. Fans shall be statically and dynamically balanced.

D. Compressor Capacity Control:

1. Electronic control.

2.8 FANS AND MOTORS

A. Indoor fan shall be direct drive plenum fan, factory installed and wired to on-board variable frequency drive and shall be equipped with slide out service access for ease of maintenance.

B. All fan motors shall be premium efficiency ODP and meet the U.S. Energy Policy Act of 2005/10 (EPACT).

C. All fan motors shall either be permanently lubricated and/or have internal thermal overload protection.

D. Outdoor fans shall be direct drive with premium efficiency motors, statically and dynamically balanced, draw through in the vertical discharge position.

E. Provide shafts constructed of solid hot rolled steel, ground and polished, with keyway, and protectively coated with lubricating oil.

2.9 HEATING

A. Fully Modulating Indirect Gas Fired Heating System:

1. Completely assembled and factory installed heating system shall be located in the primary heating position located downstream of the indoor fan assembly and be integral to unit and approved for use downstream from refrigerant cooling coils in units mounted outdoors. Threaded gas connection shall terminate at manual shut-off valve. Provide capability for sidewall or thru-base gas piping.
2. Heaters shall include high turn-down burners firing into individual stainless-steel tubular heat exchangers. Heat exchangers shall be constructed of Type 439 stainless-steel and be a high efficiency dimpled tubular design capable of draining internal condensate. Units with multiple heaters shall include one (1) fully modulating high turndown heater with additional on-off heater sections. Total heater turndown shall be based on heater gas input capacity 5:1 when ≤150 MBH or a minimum of 10:1 when >150 MBH. Staged burners are not acceptable. Burners shall be operational from 7”-14” w.c. inlet NG pressure.
3. Heater outdoor air inlet shall be hooded and include internal baffle system to prevent rain blow through. To prevent recirculation of flue gas and to prevent flue gas condensate from draining onto and obstructing the heater air inlet, the inlet shall be hooded and shall be located a minimum of 11 inches beneath the flue outlet. Inlet hood shall include bird screen.
4. Heater flue outlet(s) shall include hooded outlet with wire cloth all constructed of Type 430 stainless-steel. Hooded outlet shall be sealed to prevent flue gas recirculation.
5. Gas Burner Safety Controls: Provide safety controls for the proving of combustion air prior to ignition, continuous air proving monitoring following ignition, and continuous electronic flame supervision.
6. Inducer fan shall be direct drive high pressure centrifugal type with two (2) speeds and shall include built- in thermal overload protection.
7. Limit Controls: High temperature automatic reset limits shall be located on blower wall and in indoor fan chamber to shut off gas flow in the event of excessive temperatures resulting from restricted indoor airflow, or loss of indoor airflow.
8. Flame roll-out safeties shall provide continuous monitoring of proper burner operation.

2.10 ELECTRICAL RATINGS AND CONNECTIONS

A. All high voltage power components such as fuses, switches, and contactors shall include a service personnel protection barrier or shall be listed as touch-safe design.

B. Field wiring access to be provided through unit base into isolated enclosure with removable cover.

C. Power wiring to be single point connection.

D. Wiring internal to the unit shall be colored and numbered for identification.

E. Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.

F. Factory wired main power disconnect and overcurrent device shall be rated for total unit connected power.

G. Unit SCCR rating shall be a minimum of 5kA.

H. Factory wired voltage/phase monitor shall be included as standard. In the event of any of the following, the units will be shut down and a fault code will be stored in the monitor for the most

recent twenty-five (25) faults. Upon correction of the fault condition the unit will reset and restart automatically.

I. Phase Unbalance Protection: Factory set two percent (2%).

J. Over/Under/Brown Out Voltage Protection: Plus or minus ten percent (+/-10%) of nameplate voltage.

K. Phase Loss/Reversal.

L. Factory to mount and wire optional 120-volt convenience outlet. Field wiring of convenience outlet not acceptable.

M. All low voltage field wiring connections shall be made at factory installed low voltage terminal strip.

2.11 UNIT CONTROLS

A. Factory- engineered, mounted, configured, and tested.

B. Microprocessor control, BacNet communications interface.

C. Human interface with touch-pad screen for monitoring, setting, editing, and controlling.

D. Main Unit Controller (MCM) shall be a microprocessor-based controller with resident control logic. Controller program logic shall include:

1. Include single program with field selectable:

   a. Discharge air control with unit conditioning modes enabled based on outdoor air conditions and controlled to maintain discharge air setpoints.
   b. Space control with unit conditioning modes enabled and controlled to maintain space setpoints.

2. Single Zone Variable Air Volume (SZVAV) with unit conditioning modes enabled based on space temperature cooling setpoint and modulate supply fan to maintain setpoint. Cooling will be staged to maintain discharge air cooling setpoint. Heat will modulate to maintain space temperature with indoor fan held at maximum design airflow.

E. MCM shall:

1. Prevent simultaneous operation of any conditioning modes.
2. Accept separate setpoints for Occupied and Unoccupied states.
3. Call for dehumidification based on dew point setpoints. When no call for dehumidification is present MCM shall control calls for Cooling, Heating, and Economizer modes based on sensible or enthalpy temperature setpoints. MCM shall have onboard clock and scheduling function for occupancy.
4. Include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
5. Enable HGRH dehumidification and cooling modes and control modulation to maintain (discharge air temperature/space temperature).
6. Unit shall include minimum discharge air control.

F. Optional MCM Touch Screen shall include full color display and shall be factory installed in unit control compartment/field mounted remote from unit and field wired up to a maximum of 300 ft.

and provide a full list of points included in the MCM. The display shall provide a list and history of all unit alarms.

G. System Sensors shall include: Factory installed and wired Outdoor Air Temperature, Outdoor Air Humidity, and Evaporator Leaving Air Temperature and factory furnished, field installed Discharge Air Temperature.

1. Space Control or Single Zone VAV: Factory shall furnish Space Temperature and Space Humidity sensor for field installation and connection to the unit.
2. Economizer Option includes Return Air Temperature and Humidity sensor.
3. ERV Option includes exhaust air leaving temperature sensor.
4. Powered Exhaust with Economizer includes duct pressure sensor to be field installed.

H. System controls shall include:

1. Anti-cycle timing.
2. Minimum compressor run/off-times.

I. Factory Mounted and Wired Control Devices:

1. Outdoor Air Temperature Sensor.
2. Outdoor Air Humidity Sensor.
3. Outdoor Air Flow Measuring Station.
4. Outdoor Air Modulating Damper and Actuator.
5. Return Air/Mixed Air Modulating Damper and Actuator.
6. Return Air Temperature Sensor.
7. Return Air Humidity Sensor.
8. Return Air Duct Pressure Sensor.
9. Filter Differential Pressure Switch – Status.
10. Evaporator Leaving Air Temperature Sensor.
11. 0-10 vDc Input for Hot Gas Reheat Modulation.
12. Supply Fan Status.
13. Supply Fan Piezometer Air Flow Measuring Station.
14. Supply Fan Variable Speed Fan Control.
15. Exhaust Fan Status.
16. Exhaust Fan Piezometer Air Flow Measuring Station.
17. Exhaust Fan Variable Speed Fan Control.
18. ERV Wheel Rotation Sensor.
19. Modulating Gas Heat.
20. Unit Leaving Air Temperature Sensor for Discharge Air Temperature/Humidity for Dewpoint Control.
21. Liquid Line Pressure Sensor.
22. Suction Pressure Sensor.
23. Space Temperature.
24. Space Humidity.
25. Monitor Leaving Air Dewpoint.

2.12 POWER EXHAUST

A. Provide a factory installed power exhaust assembly that shall be designed to ventilate return air to atmosphere.

B. Plenum mounted direct drive airfoil design exhaust wheel material shall be heavy gauge aluminum, welded construction and rated for up to Class III speed/pressure performance. Belt-drive and/or forward curve plenums fans shall not be used.

C. Exhaust to discharge through powered isolation dampers located on each side of unit cabinet.

2.13 OUTDOOR AIR SECTION ENERGY RECOVERY WHEEL (ERW)

A. The rotor media shall be made of polymer, formed into a honeycomb structure to minimize pressure loss and avoid plugging. The rotor media must be coated to resist corrosion. All surfaces must be coated with a non-migrating desiccant layer to ensure that adequate latent capacity is provided. The desiccant coating must be firmly bonded to the surface and will not be dislodged when challenged with high velocity air up to 5000 feet per minute. Products that lose desiccant when served with high velocity air are not acceptable. The cassette must be a slide out design for serviceability. The media shall be cleanable with low temperature steam, hot water, or light detergent without degrading the latent recovery.

B. Sensible and latent recovery efficiencies must be clearly documented through a testing program conducted in accordance with ASHRAE Standard 84 and AHRI 1060. The testing must have been conducted by a qualified independent organization. The performance test reports must be provided for engineering review as part of the submittals for this project. Sensible and latent efficiencies must MEET OR EXCEED scheduled values.

C. The rotor design shall ensure laminar airflow to minimize parasitic pressure loss and to optimize the operating efficiency of the system fans. The pressure loss across the media shall be no greater than the scheduled pressure loss values. The energy wheel shall operate effectively up to 180 degrees F.

D. The rotor media shall be permanent, with an anticipated life of twenty (20) years. It must be tested in accordance with ASTM E 84 and provide smoke and flame spread ratings of less than 25 and 50 as required by NFPA 90A and UL 1995. A copy of the ASTM E 84 test report confirming the method of test and results shall be provided with the submittal. Heat recovery wheels incorporating “throw-away” media and tested to UL900 for Class 2 filters are not acceptable.

E. The wheel manufacturer must have been producing energy recovery wheels for a minimum of ten (10) years.

F. The rotor shall be supplied with perimeter brush seals and face contact seals to minimize air leakage and wheel bypass.

G. The rotor media shall be supported by a structural aluminum hub and aluminum reinforcing spoke system. The rotor bearings must be greaseable and provide L10 life in excess of twenty (20) years.

H. The cassette framework shall be made of galvanized steel to prevent corrosion.

I. The rotor must be driven by long-life polyurethane/polyester composite link belt system. The rotor/cassette shall be designed so that belt can be removed or serviced without the removal of the bearing. A 3-phase A/C gear motor shall be utilized to accommodate variable speed applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

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

3.2 INSTALLATION, GENERAL

A. Contractor shall install in accordance with manufacturer's instructions.

B. Mount units on roof mounting frame providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

C. Roof Curb: Install on roof structure or concrete base, level and secure, in accordance with NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" or AHRI Guideline B. Install units on curbs and coordinate roof penetrations and flashing with roof construction. Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

E. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

G. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

H. Comply with requirements for gas-fired furnace installation in NFPA 54.

I. Install separate devices furnished by manufacturer and not factory installed.

J. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to units, allow space for service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Gas Piping: Comply with requirements in Section 221623 "Facility Natural-Gas Piping."

1. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
2. Install AGA-approved flexible connectors.

E. Duct Connections:

1. Comply with requirements in Section 233113 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least ½-inch-high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 MANUFACTURER'S FIELD SERVICES

A. Unit start-up and commissioning shall be completed by a 'Factory-trained and factory-certified technician.

B. Manufacturer must have twenty (2) factory-authorized and factory-trained technicians within a 50-mile radius of job site.

C. The Contractor shall furnish manufacturer complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

3.7 STARTUP SERVICE

A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Inspect units for visible damage to furnace combustion chamber.
3. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:

a. Measure gas pressure at manifold.
b. Measure combustion-air temperature at inlet to combustion chamber.

c. Measure flue-gas temperature at furnace discharge.
d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

4. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:

   a. High-limit heat exchanger.
   b. Alarms.

5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
6. Start refrigeration system when outdoor-air temperature is within normal operating limits. and measure and record the following:

   a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
   b. Cooling coil entering-air, dry- and wet-bulb temperatures.
   c. Condenser coil entering-air dry-bulb temperature.
   d. Condenser coil leaving-air dry-bulb temperature.

7. Simulate maximum cooling demand and inspect the following:

   a. Compressor refrigerant suction and hot-gas pressures.
   b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.

8. Inspect casing insulation for integrity, moisture content, and adhesion.
9. Verify that clearances have been provided for servicing.
10. Verify that controls are connected and operable.
11. Verify that filters are installed.
12. Clean coils and inspect for construction debris.
13. Clean furnace flue and inspect for construction debris.
14. Inspect operation of power vents.
15. Purge gas line.
16. Inspect and adjust vibration isolators and seismic restraints.
17. Verify bearing lubrication.
18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
19. Adjust fan belts to proper alignment and tension.
20. Start unit.
21. Inspect and record performance of interlocks and protective devices, including response to smoke detectors by fan controls and fire alarm.
22. Operate unit for run-in period.
23. Calibrate controls.
24. Adjust and inspect high-temperature limits.
25. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
26. Verify operational sequence of controls.
27. Measure and record the following airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Relief-air flow.
    c. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate, and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.8 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within twelve (12) months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose.

3.9 CLEANING

A. After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3.11 DEMONSTRATION

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

B. Provide video recordings of how the HVAC system equipment physically operates, etc.

END OF SECTION 237433

SECTION 238129 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

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 complete VRF HVAC system(s) including, but not limited to, delegated design and the following components to make a complete operating system(s) according to requirements indicated:

1. Wall mounted indoor units.
2. Indoor, recessed, ceiling-mounted units.
3. Outdoor, air-source heat recovery heat-pump units.
4. System controls.
5. System refrigerant and oil.
6. System condensate drain piping.
7. System refrigerant piping.
8. Metal hangers and supports.
9. Metal framing systems.
10. Fastener systems.
11. Pipe stands.
12. Miscellaneous support materials.
13. Piping and tubing insulation.
14. System control cable and raceways.

1.3 SYSTEM DESCRIPTION

A. The variable capacity, heat pump heat recovery air-conditioning system shall be a Mitsubishi Electric **CITY MULTI VRF** (Variable Refrigerant Flow) zoning system.

B. The systems shall consist of outdoor units, Branch Circuit (BC) controllers, indoor Fan Coil Units (FCU), and Direct Digital Controls (DDC) – based on Diamond System Controls. Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to overall system operation. Each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for 10 minutes.

C. Alternative manufacturers shall be considered if they meet the requirements of this specification (i.e., heat recovery design, and integrated controls capable of controlling the operation, alarm capability, and setpoint adjustment of all other equipment related to the building, including but not limited to, dedicated outdoor air systems (DOAS), energy recovery ventilators (ERV), air handling units (AHU), and all other HVAC components to the extent directed in the contract documents and to the Owner’s satisfaction.

1.4 DEFINITIONS

A. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

B. Heat Recovery Heat Pump System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.

C. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as branch circuit controller, branch selector box, changeover box, flow selector unit, mode change unit, and other such terms.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

E. Three-Pipe System Design: One (1) high pressure refrigerant vapor line, one (1) low pressure refrigerant vapor line, and one (1) refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One (1) liquid line and refrigerant vapor line connect HRCUs to associated indoor units.

F. Two-Pipe System Design: One (1) refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One (1) refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two-pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high- and low-pressure refrigerant between indoor units.

G. VRF: Variable refrigerant flow.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control.
6. Include description of control software features.
7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed with supporting calculations.
8. Include refrigerant type and data sheets showing compliance with requirements indicated.
9. For system design software.
10. Indicate location and type of service access.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
5. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittals:

1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
3. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.
4. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.
6. Items penetrating finished ceiling including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Service access panels.

B. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

    a. Retain copies of Installer certificates on-site and make available on request.

2. For VRF HVAC system manufacturer.
3. For VRF HVAC system provider.

C. Seismic Qualification Data: Certificates, for equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For each type of product.

E. Product Test Reports: Where tests are required, for each product, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranties: For manufacturer's warranties.

1. Provide Manufacturer’s extended Warranty for Contractor Certified installation.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of ten (10) years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least five (5) completed projects.
4. VRF HVAC systems must be purchased from manufacturer with a commercial sales office that offers full sales support, technical support, and service operation with a minimum of ten (10) service trucks. The commercial sales office must have access to electrical sales, service, and technical software for complete submittal package and aftermarket support.
5. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.
6. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.

7. Having full-time in-house employees for the following:

    a. Product research and development.
    b. Product and application engineering.
    c. Product manufacturing, testing, and quality control.
    d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
    e. Owner training.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. In-place facility located within fifty (50) miles of Project.
3. Demonstrated past experience with products being installed for period within five (5) consecutive years before time of bid.
4. Demonstrated past experience on five (5) projects of similar complexity, scope, and value.

    a. Each person assigned to Project shall have demonstrated past experience.

5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
6. Service and maintenance staff assigned to support Project during warranty period.
7. Product parts inventory to support ongoing system operation for a period of not less than five (5) years after Substantial Completion.
8. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.

    a. Demonstrated past experience with products being installed for period within five (5) consecutive years before time of bid.
    b. Demonstrated past experience on five (5) projects of similar complexity, scope, and value.

5. Installers shall have staffing resources of competent, trained, and experienced full-time employees that are assigned to execute work according to schedule.

D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Unit shall be stored and handled according to the manufacturer's recommendations.

E. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

F. Replace installed products damaged during construction.

G. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit for shipping from the factory.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:

a. For Compressor: Ten (10) years from date of Substantial Completion.
b. For Parts, Including Controls: Ten (10) years from date of Substantial Completion.
c. For Labor: Contractor shall provide one (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design: Trane **CITY MULTI two-pipe system**, or architect approved VRF system manufacturer from the list below.

1. Daikin
2. Mitsubishi

B. The Engineer with the assistance of a Manufacturer's Representative have designed the project as a two-pipe system. Contractors who submit on a three-pipe system will be responsible for all design revisions and additional/alternative components for the installation of a fully operating three-pipe system at no additional cost to the Owner.

C. Manufacturers must meet or exceed heating and cooling capacities listed and module footprints listed. Any mechanical, structural, or electrical costs impacts due to alternate modules size will be the responsibility of alternate VRF manufacturer.

D. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Indoor and outdoor units, including accessories.
2. Controls and software.
3. HRCUs.
4. Refrigerant isolation valves.
5. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. Two-pipe system designs only. Three-pipe designs shall not be considered as equivalent.
2. System(s) operation, air-conditioning heat pump or heat recovery as indicated on Drawings.
3. Each system with one (1) refrigerant circuit shared by all indoor units connected to system.

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

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

D. ASHRAE Compliance:

1. ASHRAE 15: For safety code for mechanical refrigeration.
2. ASHRAE 62.1: For indoor air quality.
3. ASHRAE 135: For control network protocol with remote communication.
4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified specialist, as defined in Section 014000 "Quality Requirements," to design complete and operational VRF HVAC system(s) complying with requirements indicated.

1. Provide system refrigerant calculations.

a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.
b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.

2. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.
3. System Refrigerant Piping and Tubing:

a. Arrangement: Arrange piping to interconnect indoor units, HRCUs, and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.

b. Routing: Exposed piping above ceilings and behind walls to maximum extent possible.
c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated.

4. System Controls:

a. Network arrangement.
b. Network interface with other building systems.
c. Product selection.
d. Sizing.

B. Service Access:

1. Provide and document service access requirements.
2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
6. Comply with OSHA regulations.

C. System Design and Installation Requirements:

1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

D. Isolation of Equipment: Provide isolation valves to isolate each HRCU, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation. Isolation Valves to be provided by equipment manufacturer.

E. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:

1. Range acceptable to manufacturer.

F. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in the system.

G. Outdoor Conditions:

1. Suitable for outdoor ambient conditions encountered.

a. Design equipment and supports to withstand wind loads of governing code.
b. Design equipment and supports to withstand snow and ice loads of governing code.

H. Seismic Performance: VRF HVAC system(s) shall withstand the effects of earthquake motions determined according to governing code.

I. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.

1. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."
2. Outdoor: Within ordinance of governing authorities, however, outdoor units shall be of the quietest sound levels available from the manufacturer.
3. Sound requirements for each indoor unit space.

a. Classrooms shall be less than or equal to 35 dBA (55dBC).
b. Offices, Cafeteria, Offices, Storage Rooms, and other miscellaneous areas shall be less than or equal to 40 dBA (60dBC).

J. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.

K. Capacities and Characteristics: As indicated on Drawings.

2.4 WALL MOUNTED INDOOR UNIT

A. General:

1. The wall-mounted indoor unit shall be factory assembled, wired, and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board, and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Unit Cabinet:

1. All casings, regardless of model size, shall have the same white finish.
2. Multi-directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining are required.
3. There shall be a separate back plate which secures the unit firmly to the wall.

C. Fan:

1. The indoor fan shall be statically and dynamically balanced to run on a single motor with permanently lubricated bearings.
2. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
3. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

D. Filter:

1. Return air shall be filtered by means of an easily removable, washable filter.

E. Coil:

1. Basis-of-design indoor units include factory-installed LEV/EEV. Alternative brands which require field-installed, accessory LEV or EEV kits are permissible only with written Engineer and Architect approval for the location of kits being submitted two (2) weeks prior to bid date.

EEV kits mounted in cavities inside fire-rated interior walls shall be mounted inside 3-hour fire rated enclosures with access panels supplied by the manufacturer. Enclosure type and placement require prior approval.

2. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
3. The coils shall be pressure tested at the factory.

F. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

G. Controls:

1. The unit shall include an IR receiver for wireless remote-control flexibility.
2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F–9.0°F adjustable deadband from set point.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.5 INDOOR, RECESSED, CEILING-MOUNTED UNITS (4-WAY)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections. Units shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
3. For 3-foot x 3-foot cassette cabinets, provide a 4-foot x 4-foot architectural lay-in to facilitate installation (PLFY-ITP1).
4. Four-way grille shall be fixed to bottom of cabinet allowing selectable two-, three-, or four-way supply.
5. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
6. Mounting: Manufacturer-designed provisions for field installation.
7. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless-steel.

2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance. Tubing shall have inner grooves for high efficiency heat exchange.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Internal Tubing: Copper tubing with brazed joints.
6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.
10. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water above the condensate pan and to the condensate removal piping system as shown on the Drawings.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

    a. Direct-drive arrangement.
    b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
    d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (2) (low, high), three (3) (low, medium, high), or more than three (3) speed settings or variable speed with a speed range of least fifty percent (50%).
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, to accommodate filter replacement without the need for tools.
2. Media: Washable: Manufacturer's standard filter with antimicrobial treatment.

G. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.

1. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.

    a. Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
    b. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.

2. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.

3. Additional Branch Supply Duct Connection: Sheet metal knockout for optional connection to one (1) additional supply branch duct for multi-directional discharge units.

H. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.

I. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to filtered, outdoor air ventilation supply duct.

J. Unit Accessories:

1. Outdoor Air Motorized Dampers: Contractor to provide motorized damper, relay, power, and wire interlock operation with indoor unit on CN28 Terminal.

K. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors: Unit inlet air temperature Coil entering refrigerant temperature Coil leaving refrigerant temperature.
4. Field-Customizable I/O Capability:

   a. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
   b. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

5. Features and Functions: Self-diagnostics, time delay, auto-restart, auto operation mode, manual operation mode, filter service notification, power consumption display, drain assembly high water level safety shutdown and notification, run test switch.
6. Communication: Network communication with other indoor units and outdoor unit(s).
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
9. System shall auto-restart on Power Failure. Each indoor unit shall be able to lose power without taking down the entire system.

L. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.
7. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
8. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz).

2.6 OUTDOOR, AIR-SOURCE, HEAT-RECOVERY HEAT PUMP UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.
4. Outdoor units shall provide guaranteed heating capacity of seventy percent (70%) at -22°F ambient temperatures, extended heating operation down to -31°F, and cooling mode operation down to 23°F ambient temperatures, without additional low ambient controls. If an alternate manufacturer other than the Basis-of-Design manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the Contractor.

B. BASIS-OF-DESIGN OUTDOOR UNIT:

1. The **R2-Series (Hyper-Heat Simultaneous Heat/Cool) TURY** outdoor units shall be used specifically with **CITY MULTI VRF** components. The **TURY** outdoor units shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped, and wired and run tested at the factory.
2. The model nomenclature and unit requirements are shown below. All units requiring factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the Contractor.

Outdoor Unit Model Nomenclature		
460 Volt		Twinning Kit
Model Number	Units	
TURYH1444BN40AN	(2) TURYH0724AN40AN	CMY-R100NCBK

C. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

D. Compressor and Motor Assembly:

1. One (1) or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to nineteen to five percent (19-5%) of rated capacity, depending upon unit size. Non-inverter driven compressors, which result in larger inrush currents and require larger wire sizing, shall not be allowed.
2. Protection: Integral protection against the following:

    a. High refrigerant pressure safety switch.
    b. Low oil level.
    c. High oil temperature.
    d. Thermal and overload.
    e. Voltage fluctuations and over-current protection.
    f. Phase failure and phase reversal.
    g. DC bus protection.
    h. Short-cycling of compressor.

3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Accumulator with refrigerant level sensors and controls.
7. Crankcase heaters with integral control to maintain safe operating temperature.
8. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
9. Fusible plug.

E. Refrigerant:

1. R410A refrigerant shall be required for outdoor unit systems.
2. Polyolester (POE) oil shall be required.

F. Condenser Coil Assembly:

1. Plate Fin Coils:

a. Casing: Aluminum, galvanized, or stainless-steel.
b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
c. Tubes: Copper, of diameter and thickness required by performance.
d. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
e. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
f. The coil shall be protected with an integral metal guard.
g. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

G. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.

a. Direct-drive, variable-speed, propeller-type fan arrangement.
b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
c. Statically and dynamically balanced.
d. Vertical discharge airflow.

2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
5. Speed Settings and Control: Variable speed with a speed range of least seventy-five percent (75%).
6. Vibration Control: Integral isolation to dampen vibration transmission.

H. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

1. Provide a factory drain pan heater to prevent ice buildup on condensing unit drain pan during long periods of heating operation.

I. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2. The outdoor unit shall have the capability of up to eight (8) levels of demand control for each refrigerant system.
3. Factory-Installed Controller: Configurable digital control.
4. Factory-Installed Sensors:

    a. Refrigerant suction temperature.
    b. Refrigerant discharge temperature.
    c. Outdoor air temperature.
    d. Refrigerant high pressure.
    e. Refrigerant low pressure.
    f. Oil level.
    g. High efficiency oil separator plus additional logic controls to ensure adequate compressor oil volume is maintained.

5. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback control, power consumption display, run test switch, and equalization of run time between multiple similar components.
6. VRF manufacturer must be able to do both Simultaneous Defrost and Reverse Defrost based on ambient temperature on both twinned and single modules. Manufacturer must bypass refrigerant in Branch Device and not flow refrigerant through indoor units in reverse defrost mode. During Simultaneous mode Indoor units shall automatically switch to low fan speed to keep high Leaving air temp off indoor units.
7. Communication: Network communication with indoor units and other outdoor unit(s).
8. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
9. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

J. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz.
4. The outdoor unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz).
5. The outdoor unit shall be controlled by integral microprocessors.
6. The control circuit between the indoor units, HRCU’s and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
7. Disconnecting Means: Unit shall be furnished with factory-mounted (preferably) circuit breaker or switch, complying with NFPA 70.
8. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
9. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
10. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

K. Unit Hardware: Zinc-plated steel or stainless-steel.

L. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.7 HEAT RECOVERY CONTROL UNITS (HRCUs)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections. The HRCUs, or BC (Branch Circuit) Controllers, shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one (1) unit or multiple units that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices with no subcooling are not allowed.
4. HRCUs shall be specifically used with R410A systems.
5. HRCUs shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary for operation.
6. HRCUs shall be mounted indoors, with access and service clearance provided for each controller.
7. HRCUs shall be suitable for use in plenums in accordance with UL199.

B. Cabinet:

1. Galvanized-steel construction.
2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
3. The unit shall house two (2) tube-in-tube heat exchangers.
4. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
5. Mounting: Manufacturer-designed provisions for field installation.
6. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

    a. All branch devices shall have bottom access for service, devices that require top access shall pay for additional GC costs to provide ceiling or plenum space height increase to meet their published service clearances and be considered an alternate only. Alternate approved VRF Manufacturers shall be responsible for all costs associated with additional branch device quantities, including but not limited additional electrical costs, refrigerant expansion joints and design, structural changes, and additional service/access panels.

7. System Design: Each VRF System shall be provided with at least one (1) spare port on one (1) of the downstream branch controller(s) to allow for future expansion and system changes as necessary.

C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

D. Refrigeration Assemblies and Specialties:

1. Specially designed by manufacturer for type of two-pipe VRF HVAC system being installed.
2. All HRCU refrigerant pipe connections shall be brazed or flared.
3. Each refrigerant branch circuit shall have multiple, two-position refrigerant control valve(s) to control refrigerant flow.
4. Each system piping connection upstream of heat recovery unit shall be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system. Isolation valves shall be provided by the VRF equipment manufacturer.
5. Each branch circuit connection shall be fitted with service shut-off valves and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.
6. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

E. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Features and Functions: Self-diagnostics, fuse protection.
4. Communication: Network communication with indoor units and outdoor unit(s).
5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

F. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.
7. The unit electrical power shall be 208/230 volts, 1-phase, 60 Hertz.
8. The unit shall be capable of satisfactory operation within voltage limits of 187-228 (208V/60Hz).
9. The HRCU shall be controlled by integral microprocessors.
10. The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

G. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.8 SYSTEM CONTROLS

A. General Requirements:

1. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. The BMS shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface or any local system touch screen controllers.

    a. The Basis-of-Design Manufacturer's control system operates at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

        1) Equipment manufacturer to provide central controller and any expansion controller needed to monitor VRF system. Provide BACnet interface for communicating with BMS.
        2) Room Temperature Thermostat: Provide **Simple MA TAC-YT53CRAU** for each zone.
        3) Power loss to one (1) indoor unit will not cause system shutdown and the system will continue to operate normally. Any cost from system shutdown due to indoor unit power loss from alternate manufacturer will be one hundred percent (100%) incurred on the installing contractor.

    b. System controls and control components shall be installed in accordance with the manufacturer's written installation instructions.

2. System shall be furnished with energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.
3. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.
4. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control, and general equipment control.
5. System shall be capable of email generation for remote alarm annunciation.
6. Control system start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in the manufacturer's specific controls system configuration and operation. The representative shall provide proof of certification in training indicating successful completion of no more than two (2) years prior to system installation and shall consist of a minimum of one (1), 8-hour period completed during normal working hours.
7. Network: Indoor units, HRCUs, and outdoor units shall include integral controls and connect through a manufacturer-selected control network.
8. Network Communication Protocol: Manufacturer proprietary and open control communication between interconnected units.
9. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:

    a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.
    b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.
    c. Integration shall include control, monitoring, scheduling, change of value notifications, data trending and programming.

10. Operator Interface:

    a. Operators shall interface with system and unit controls through the following:

        1) Operator interfaces integral to controllers.

2) Owner-furnished PC connected to central controller(s).
3) Web interface through web browser software.
4) Integration with Building Automation System.

b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

1) On/off control.
2) Temperature set-point adjustment.

B. VRF HVAC System Operator Software for PC:

1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
9. Supports Multiple Languages: English.
10. Supports Imperial and Metric Temperature Units: Fahrenheit and Celsius.
11. Displays service notifications and error codes.
12. Monitors and displays up to 3000-item error history and 10000-item operation history for regular reporting and further archiving.
13. Monitors and displays cumulative operating time of indoor units.
14. Able to disable and enable operation of individual controllers for indoor units.
15. Information displayed on individual controllers shall also be available for display.
16. Information displayed for outdoor units, including refrigerant high- and low-pressures, percent capacity, and alarm.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.

a. Include multiple interconnected controllers as required. A minimum of one (1) TE200 Controller with additional expansion modules capable of interconnecting the remaining equipment is anticipated.

2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

a. Sets schedule for daily, weekly, and annual events.
b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.

4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start-feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.
10. Information displayed for outdoor units, including refrigerant high and low pressures, percent capacity, and alarm.
11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
12. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software.

2.9 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, Class A1 refrigerant classification.
3. R-410a.

B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

a. Polyolester (POE) oil shall be required for the Basis-of-Design Manufacturer's equipment. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two (2) weeks prior to bidding.

2.10 SYSTEM CONDENSATE DRAIN PIPING

A. If more than one (1) material is listed, material selection is Contractor's option.

B. Copper Tubing:

1. Drawn-Temper Tubing: According to ASTM B 88, Type L or Type DWV according to ASTM B 306.
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B 32, lead-free alloys, and water-flushable flux according to ASTM B 813.

C. PVC plastic pipe according to ASTM D 1785, Schedule 40, with socket-type pipe fittings according to ASTM D 2466 and solvent cement according to ASTM D 2564, primer according to ASTM F 656.

2.11 SYSTEM REFRIGERANT PIPING

A. Comply with requirements in Section 232300 "Refrigerant Piping" for system piping requirements.

B. Refrigerant Tubing Kits:

1. Furnished by VRF HVAC system manufacturer.
2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
3. Standard one-piece length for connecting to indoor units.
4. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
5. Factory Charge: Dehydrated air or nitrogen.

C. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

D. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
2. Seals: Compatible with system refrigerant and oil. Seal service life of at least twenty (20) years.
3. Valve Connections: Flare or sweat depending on size.

2.12 METAL HANGERS AND SUPPORTS

A. Copper Tube Hangers:

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

B. Plastic Pipe Hangers:

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

2.13 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated, pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel for use indoors and of stainless-steel for use outdoors.
6. Metallic Coating for Use Indoors: Electroplated zinc, hot-dip galvanized, or mill galvanized.
7. Plastic Coating for Use Outdoors: PVC, epoxy, or polyester.

2.14 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded, zinc-coated 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 anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated or stainless-steel.
2. Outdoor Applications: Stainless-steel.

2.15 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. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless-steel.
3. Vertical Members: Two (2) or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One (1) or more; plastic.
3. Vertical Members: Two (2) or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

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

2.16 MISCELLANEOUS SUPPORT MATERIALS

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

1. Properties: Non-staining, non-corrosive, and non-gaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

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

C. Threaded Rods: Continuously threaded. Zinc-plated steel or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar material as rods.

2.17 PIPING AND TUBING INSULATION

A. Comply with requirements in Section 230700 "HVAC Insulation" for system piping insulation requirements.

B. Condensate Drain Piping and Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:

a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C 534, Type I for tubular materials.
b. Indoors: ¾-inch-thick.
c. Outdoors: 1-inch-thick.

2. Field-Applied Jacket:

a. Concealed: None required.
b. Indoors, Exposed to View: PVC, 20 mils thick, color selected by Architect and Owner from manufacturer's entire range.
c. Outdoors, Exposed to View: Aluminum, smooth, 0.020-inch-thick.

C. Refrigerant Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:

a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C 534, Type I for tubular materials.
b. Indoors: 1-inch-thick.
c. Outdoors: 1-inch-thick.

2. Field-Applied Jacket:

a. Concealed: None required.
b. Indoors, Exposed to View: PVC, color selected by Architect, 20 mils thick.
c. Outdoors, Exposed to View: Aluminum, smooth, 0.020-inch-thick.

D. Flexible Elastomeric Insulation Adhesive: Comply with MIL-A-24179A, Type II, Class I.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

F. Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

2.18 SYSTEM CONTROL CABLE

A. Cable Rating: Listed and labeled for application according to NFPA 70.

1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

a. Flame Travel Distance: 60 inches or less.
b. Peak Optical Smoke Density: 0.5 or less.
c. Average Optical Smoke Density: 0.15 or less.

2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

B. Low-Voltage Control Cabling:

1. Paired Cable: NFPA 70, Type CMG.

a. One-pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
b. PVC insulation.
c. Braided or foil shielded.
d. PVC jacket.
e. Flame Resistance: Comply with UL 1685.

C. TIA-485A Network Cabling:

1. Standard Cable: NFPA 70, Type CMG.

a. Paired, one-pair, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
b. PVC insulation.
c. Unshielded.
d. PVC jacket.
e. Flame Resistance: Comply with UL 1685.

D. Ethernet Network Cabling: TIA-568-C.2 Category 6 cable with RJ-45 connectors.

1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.
2. Conductors: 100-ohm, 23 AWG solid copper.
3. Shielding: Shielded twisted pairs (FTP).
4. Cable Rating: By application.
5. Jacket: Gray or blue thermoplastic.

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for control wiring and cable raceways.

2.19 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.
2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

1. Loose components shall be installed by manufacturer's service representative or system Installer under supervision of manufacturer's service representative.

C. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8-inch.

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25-inch.

H. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.

I. Floor-mounted units located in mechanical rooms.

J. Install floor-mounted units on support structure indicated on Drawings.

K. Attachment: Install hardware for proper attachment to supported equipment.

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

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Install outdoor units on support structures indicated on Drawings.

C. Roof-Mounted Installations: Install outdoor units on equipment supports. Anchor units to supports with removable, stainless-steel fasteners.

D. Install units on factory mounted stand.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

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

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.
2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

    a. Details indicated on Drawings.
    b. Manufacturer's requirements.
    c. Governing codes.
    d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:

1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet. Minimum rod size, ¼-inch.
3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.

F. Install refrigerant piping and tubing in protective conduit where installed belowground.

G. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

H. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps to entrain oil in vertical runs.
4. Liquid lines may be installed level.

I. When brazing, remove or protect components that could be damaged by heat.

J. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

K. Joint Construction:

1. Ream ends of tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
3. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

    a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
    b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.8 INSTALLATION OF METAL HANGERS AND SUPPORTS

A. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

B. 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.

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

D. Comply with MFMA-103 for metal framing system selections and applications that are not specified.

E. Fastener System Installation:

1. Install powder-actuated fasteners, for use in lightweight concrete or concrete slabs less than 4 inches 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.
3. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

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.

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

H. 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.

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

J. Install building attachments within concrete slabs or attach to structural steel.

1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

L. 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.

M. Piping and Tubing Insulation:

1. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
2. Shield Dimensions for Pipe: Not less than the following:

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

N. Horizontal-Piping Hangers and Supports: Install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
3. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
4. Multiple horizontal pipes located indoors may use metal framing systems with split clamp attachment for each pipe in lieu of individual clevis hangers.
5. Pipe stands for horizontal pipes located outdoors.

6. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
7. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

O. Horizontal Piping Hanger Spacing and Rod Size: Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:

1. Sizes through NPS 3/4: Maximum span, 5 feet; minimum rod size, ¼-inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, ¼-inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8-inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8-inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8-inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8-inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8-inch.

P. Plastic Pipe Hanger and Support Spacing:

1. Space hangers and supports according to pipe manufacturer's written instructions for service conditions.
2. Maximum spacing, 5 feet; minimum rod size, ¼-inch.

Q. Vertical-Piping Clamps: Install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): If longer ends are required for riser clamps.

R. Support vertical runs at roof, at each floor, and at midpoint intervals between floors, not to exceed 10 feet.

S. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified.

T. Use hangers, supports, and attachments with galvanized coatings unless otherwise indicated.

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

V. Trim excess length of continuous-thread hanger and support rods to 1-inch.

W. Hanger-Rod Attachments: Install the following types:

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

X. Building Attachments: Install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

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

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

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

3.9 INSTALLATION OF PIPING AND TUBING INSULATION

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

B. 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.

C. 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 unavailable, 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. 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.

D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two (2) continuous beads of adhesive to seams and joints, one (1) bead under lap and the finish bead along seam and joint edge.

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

3.10 INSTALLATION OF DUCT, ACCESSORIES, AND AIR OUTLETS

A. Where installing ductwork adjacent to equipment, allow space for service and maintenance.

B. Comply with requirements for metal ducts specified in Section 233113 "Metal Ducts."

C. Comply with requirements for air duct accessories specified in Section 233300 "Air Duct Accessories."

D. Comply with requirements for flexible ducts specified in Section 233346 "Flexible Ducts."

E. Comply with requirements for air diffusers, registers and grilles specified in Section 233713 "Diffusers, Registers, and Grilles."

3.11 ELECTRICAL INSTALLATION

A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.

B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.

1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

E. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least ½-inch-high.
2. Locate nameplate or label where easily visible.

G. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2½ inches deep.
2. Outlet boxes for cables shall be no smaller than 4 inches square by 1½ inches deep with extension ring sized to bring edge of ring to within 1/8-inch of the finished wall surface.
3. Flexible metal conduit shall not be used.

H. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

I. Install manufactured conduit sweeps and long-radius elbows if possible.

J. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.12 SOFTWARE

A. Cybersecurity:

1. Software:

a. Coordinate security requirements with IT department.
b. Ensure that latest stable software release is installed and properly operating.
c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight (8) characters in length. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

a. Coordinate location and access requirements with IT department.
b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
c. Disable dual network connections.

3.13 INSTALLATION OF SYSTEM CONTROL CABLE

A. Comply with NECA 1.

B. Installation Method:

1. Install cables in raceways except as follows:

a. Within equipment and associated control enclosures.
b. In accessible ceiling spaces where open cable installation method may be used.
c. In gypsum board partitions where cable may be enclosed within wall cavity.

2. Conceal raceway and cables except in unfinished spaces.

C. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.
5. Cables serving a common system may be grouped in a common raceway. Install control cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles or access panels.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals.
15. Do not bend cables in a radius less than ten (10) times the cable OD.
16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
17. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist balanced twisted-pair cables more than ½-inch at the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
2. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.

3.14 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.15 GROUNDING INSTALLATION

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.16 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."

B. Identify system electrical and controls components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3.17 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.

a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.

2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

a. First Visit: Kick-off meeting.
b. Second Visit: At approximately twenty-five percent (25%) completion of system(s).
c. Third Visit: At approximately fifty percent (50%) completion of system(s).
d. Fourth Visit: At approximately seventy-five percent (75%) completion of system(s).
e. Fifth Visit: Final inspection before system startup.

3. Kick-off Meeting:

a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
c. Meeting shall cover the following as a minimum requirement:

1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
2) Manufacturer's installation requirements specific to systems being installed.
3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
4) Required field activities related installation of VRF HVAC system.
5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit shall include the following:

    a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
    b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
    c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
    d. Advise and if necessary, assist Installer with updating related refrigerant calculations and system documentation.
    e. Issue a report for each visit, documenting the visit.

        1) Report to include name and contact information of individual making the visit.
        2) Date(s) and time frames while on-site.
        3) Names and contact information of people meeting with while on-site.
        4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:

    a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.
    b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
    c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
    d. Inspection reports for indoor units shall include, but not be limited to, the following:

        1) Unit designation on Drawings.
        2) Manufacturer model number.
        3) Serial number.
        4) Network address, if applicable.
        5) Each equipment setting.
        6) Mounting, supports, and restraints properly installed.
        7) Proper service clearance provided.
        8) Wiring and power connections correct.
        9) Line-voltage reading(s) within acceptable range.
        10) Wiring and controls connections correct.
        11) Low-voltage reading(s) within an acceptable range.
        12) Controller type and model controlling unit.
        13) Controller location.
        14) Temperature settings and readings within an acceptable range.
        15) Humidity settings and readings within an acceptable range.
        16) Condensate removal acceptable.
        17) Fan settings and readings within an acceptable range.
        18) Unit airflow direction within an acceptable range.
        19) If applicable, fan external static pressure setting.
        20) Filter type and condition acceptable.
        21) Noise level within an acceptable range.
        22) Refrigerant piping properly connected and insulated.

23) Condensate drain piping properly connected and insulated.
24) If applicable, ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Condensate removal acceptable.
13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.
16) Remarks.

f. Inspection reports for indoor, dedicated outdoor air ventilation units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Fan external static pressure setting.
19) Filter type and condition acceptable.
20) Noise level within an acceptable range.
21) Refrigerant piping properly connected and insulated.
22) Condensate drain piping properly connected and insulated.
23) Automatic dampers properly installed and operating.
24) Ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

g. Installer shall provide manufacturer with the requested documentation and technical support during inspection.

h. Installer shall correct observed deficiencies found by the inspection.
i. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
j. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
k. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.2 times VRF HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature is acceptable.
4. Prepare test report to record the following information for each test:

a. Name of person starting test, company name, phone number, and e-mail address.
b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
c. Detailed description of extent of tubing tested.
d. Date and time at start of test.
e. Test pressure at start of test.
f. Outdoor temperature at start of test.
g. Name of person ending test, company name, phone number, and e-mail address.
h. Date and time at end of test.
i. Test pressure at end of test.
j. Outdoor temperature at end of test.
k. Remarks:

5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500.

3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 1 hour with no change.
4. Prepare test report to record the following information for each test:

    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.
    j. Outdoor temperature at end of test.
    k. Remarks:

5. Submit test reports for Project record.
6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by system manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.18 STARTUP SERVICE

A. Engage a VRF Technical Specialist to perform Startup Assistance. Contractor to review startup checklist with Technical Specialist prior to startup.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).
2. Check each indoor unit's response to demand for cooling and heating.
3. Check each indoor unit's response to changes in airflow settings.
4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
5. Check sound levels of each indoor and outdoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.
2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer shall electronically record not less than 2 hours of continuous operation of each system and submit with report for historical reference.

    a. All available system operating parameters shall be included in the information submitted.

E. Witness:

1. Invite Architect and Owner to witness startup service procedures.
2. Provide written notice not less than fourteen (14) business days before start of startup service.

3.19 ADJUSTING

A. Adjust equipment and components to function smoothly and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

D. Occupancy Adjustments: When requested within twelve (12) months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose.

3.20 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.

B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.

C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.21 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include twelve (12) months' full maintenance by skilled employees of system Installer who are manufacturer's authorized service representative. Include two (2) service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.22 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two (2) years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least thirty (30) days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.23 DEMONSTRATION

A. Engage a VRF Technical Specialist to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:

1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.
2. Instructor's credentials shall be submitted for review before scheduling training.
3. Instructor(s) primary job responsibility shall be Owner training.
4. Instructor(s) shall have not less than three (3) years of training experience with VRF HVAC system manufacturer and past training experience on at least three (3) projects of comparable size and complexity.

C. Schedule and Duration:

1. Schedule training with Owner at least twenty (20) business days before first training session.
2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.
4. Each training day shall not exceed 8 hours of training. Daily training schedule shall allow time for 1-hour lunch period and 15-minute break after every 2 hours of training.
5. Perform not less than 16 total hours of training.

D. Location: Owner shall provide a suitable on-site location to host classroom training.

E. Training Attendees: Assume five (5) people. Verify with Owner at the time of scheduling training for actual number of attendees.

F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.

G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

H. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

I. Acceptance: Obtain Owner written acceptance that training is complete, and requirements indicated have been satisfied.

J. Provide video recordings of how the HVAC system equipment physically operates, etc.

END OF SECTION 238129

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So, connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 078413 "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052-inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and one (1) or more sides equal to, or more than, 16 inches, thickness shall be 0.138-inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM and/or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Stainless steel. Include two (2) for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one (1) for each sealing element.

2.3 GROUT

A. Non-metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, non-metallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide ½-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Section 078413 "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install them in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078413 "Penetration Firestopping."

3.5 COMISSIONING OF EQUIPMENT

A. Engage a factory authorized service representative, who is familiar with this project, to participate and assist, if necessary, in the functional performance testing of the equipment included in this Division with the Commissioning Agent.

END OF SECTION 260500

SECTION 260509 - ELECTRICAL DEMOLITION REQUIREMENTS

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. Demolition involving electrical system as described in Contract Documents.

B. Related Sections:

1. Section 260500 “Common Work Results for Electrical”
2. New and replacement work specified in appropriate specification sections.

1.3 SCHEDULING

A. Include on Construction Schedule sequence of individual electrical demolition operations.

B. Coordinate with Owner for equipment and materials to be removed by Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. All relocations, reconnections and removals are not necessarily indicated on Drawings. All such work shall be included without additional cost to the Owner.

3.2 PREPARATION

A. Disconnect equipment that is to be removed or relocated. Carefully remove, disassemble, or dismantle as required, and store in approved location on site, existing items to be reused in completed work.

B. Where affected by demolition or new construction, relocate, extend, or repair raceways, conductors, outlets and apparatus to allow continued use of electrical system. Use methods and materials as specified for new construction.

3.3 PERFORMANCE

A. Perform drilling, cutting, block-offs and demolition work required for removal of necessary portions of electrical system. Do not cut joists, beams, girders, trusses, or columns without prior written permission from Architect.

B. Remove concealed wiring abandoned due to demolition or new construction. Remove circuits, conduits and conductors that are not to be re-used back to next active fixture, device, or junction box.

C. Patch, repair, and finish surfaces affected by electrical demolition work, unless work is specifically called for under other Sections of the specifications.

3.4 CLEANING

A. Remove obsolete raceways, conductors, apparatus, and lighting fixtures promptly from site and dispose of legally.

END OF SECTION 260509

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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 NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. Alcan Products Corporation; Alcan Cable Division
2. American Insulated Wire Corp.; a Leviton Company
3. Belden
4. General Cable Corporation
5. Senator Wire & Cable Company
6. Southwire Company

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

D. Multi-conductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC, mineral-insulated, and metal-sheathed cable, Type MI with ground wire.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC
4. 3M; Electrical Products Division
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Comply with requirements of Section 260500 “Common Work Results for Electrical” for sleeves.

2.4 SLEEVE SEALS

A. Comply with requirements of Section 260500 “Common Work Results for Electrical” for sleeve seals.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for all feeders including service entrance cables. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTI-CONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway and metal-clad cable, Type MC.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway and metal-clad cable, Type MC.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Installed Below Raised Flooring: Type THHN-THWN, single conductors in raceway and metal-clad cable, Type MC.

J. Branch Circuits in Cable Tray: Type THHN-THWN, single conductors in raceway and metal-clad cable, Type MC.

K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

L. Class 1 Control Circuits: Type THHN-THWN, in raceway.

M. Class 2 Control Circuits: Type THHN-THWN, in raceway Power-limited cable, concealed in building finishes, Power-limited tray cable, in cable tray.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Comply with requirements of Section 260500 “Common Work Results for Electrical” for sleeves.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 078413 "Penetration Firestopping."

3.6 SLEEVE-SEAL INSTALLATION

A. Comply with requirements of Section 260500 “Common Work Results for Electrical” for sleeve seals.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

    a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

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. UTP cabling.
2. 50/125 and 62.5/125-micrometer, multi-mode optical fiber cabling.
3. RS-232 cabling.
4. RS-485 cabling.
5. Low-voltage control cabling.
6. Control-circuit conductors.
7. Identification products.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. Ladder Cable Tray: A fabricated structure consisting of two (2) longitudinal side rails connected by individual transverse members (rungs).

F. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

G. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

H. RCDD: Registered Communications Distribution Designer.

I. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.

J. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using seventy-five percent (75%) or less of the plan area of the surface to support cables.

K. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Shop Drawings: For cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

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

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install UTP and optical fiber cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is

operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of Category 6A and Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Cable Trays:

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

a. Cable Management Solutions, Inc.
b. Cablofil Inc.
c. Cooper B-Line, Inc.
d. Cope - Tyco/Allied Tube & Conduit
e. GS Metals Corp.

2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472-inch-thick hot-dip galvanizing, complying with ASTM A 123, Grade 0.55, not less than 0.002165-inch-thick.

a. Basket Cable Trays: Minimum 6 inches wide and 2 inches deep. Wire mesh spacing shall not exceed 2 by 4 inches.
b. Trough or Ventilated Cable Trays: Minimum nominally 6 inches wide.
c. Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches.
d. Channel Cable Trays: One-piece construction, nominally 4 inches wide. Slot spacing shall not exceed 4½ inches o.c.
e. Solid-Bottom or Non-ventilated Cable Trays: One-piece construction, nominally 12 inches wide. Provide with solid covers.

C. Conduit and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2½ inches deep.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, ¾ by 48 by 96 inches.

2.3 UTP CABLE

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

1. Berk-Tek; a Nexans company
2. CommScope, Inc.
3. Mohawk; a division of Belden CDT
4. Superior Essex Inc.

B. Description: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket unless color is otherwise specified in another section.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP complying with UL 1685.
b. Communications, Riser Rated: Type CMP or Type CMR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.4 UTP CABLE HARDWARE

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

1. Hubbell Premise Wiring
2. Orthotronics
3. Leviton Voice & Data Division
4. Panduit Corp.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110 style for Category 6. Provide blocks for the number of cables terminated on the block, plus twenty-five percent (25%) spare; integral with connector bodies, including plugs and jacks where indicated.

2.5 OPTICAL FIBER CABLE

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

1. ADC
2. American Technology Systems Industries, Inc.
3. Berk-Tek; a Nexans company
4. Corning Cable Systems
5. Dynacom Corporation

B. Description: Unless modified by another section - Multimode, 50/125-micrometer, 12-fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA/EIA-492AAAA-B for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

a. General Purpose, Non-conductive: Type OFN or OFNG.
b. Riser Rated, Non-conductive: Type OFNR, complying with UL 1666.

5. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
7. Plenum Rated, Non-conductive: Type OFNP, complying with NFPA 262.

C. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

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

1. Berk-Tek; a Nexans company
2. CommScope, Inc.
3. Corning Cable Systems
4. Dynacom Corporation
5. Siemon Co. (The)

B. Cable Connecting Hardware: Comply with the Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

1. Quick-connect, simplex and duplex, Type SC, Type ST, Type LC, Type MT-RJ connectors. Insertion loss not more than 0.75 dB.
2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 RS-232 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two (2) pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with one hundred percent (100%) shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.8 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two (2) pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.

5. Flame Resistance: NFPA 262, Flame Test.

2.9 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One (1) pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One (1) pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.10 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83 and/or UL 44.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, Type XHHN, in raceway, power-limited cable, concealed in building finishes, power-limited tray cable, in cable tray, complying with UL 83 and/or UL 44.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.11 IDENTIFICATION PRODUCTS

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

1. Brady Corporation
2. HellermannTyton
3. Kroy LLC
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows if possible.

E. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Do not untwist UTP cables more than ½-inch from the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceway and Boxes for Electrical Systems."

E. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

F. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

G. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 72 inches long shall be neatly coiled not less than 12 inches in diameter below each feed point.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in non-metallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2½ inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin

assignments and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment, and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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 grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Foundation steel electrodes.

1.3 SUBMITTALS

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

B. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Ground rods.
2. Grounding arrangements and connections for separately derived systems.
3. Grounding for sensitive electronic equipment.
4. Test Wells.

C. Qualification Data: For qualified testing agency and testing agency's field supervisor.

D. Field quality-control reports.

E. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS and NFPA 70B.

a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, ¼-inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16-inch-thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16-inch-thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, ¼ by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two (2) bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression and exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad, sectional type; ¾ inch in diameter by 10 feet.

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.

1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three (3) bands of green and two (2) bands of yellow.

D. Grounding Bus: Install in electrical and network equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes: Install a driven ground rod through manhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-

shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and a ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ¼-by-4-by-12-inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until the tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three (3) rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one (1) test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes;

use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one (1) of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

3.7 LABELING

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Contractor shall engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal**,** at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two (2) full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order,

and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five (5) times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.
3. Associated hardware.
4. Clamps.
5. Hangers.
6. Fasteners.
7. Anchors.
8. Brackets.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.7 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 installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA 4, factory-fabricated components for field assembly.

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. Allied Tube & Conduit
b. Cooper B-Line, Inc.; a division of Cooper Industries
c. ERICO International Corporation
d. GS Metals Corp.
e. Thomas & Betts Corporation
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Non-metallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Non-metallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least one (1) surface.

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. Allied Tube & Conduit
    b. Cooper B-Line, Inc.; a division of Cooper Industries
    c. Fabco Plastics Wholesale Limited
    d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless-steel.
4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated and stainless-steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) Cooper B-Line, Inc.; a division of Cooper Industries
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be ¼-inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least twenty-five percent (25%) in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1½-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To New Concrete: Bolt to concrete inserts.
2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3. To Existing Concrete: Expansion anchor fasteners.
4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
5. To Steel: Welded threaded studs complying with AWS D1.1, with lock washers and nuts, Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, Spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, twenty-eight (28) day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

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 minimum dry film thickness of 2.0 mils.

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

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical non-metallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible non-metallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RMC: Rigid metal conduit.

J. RNC: Rigid non-metallic conduit.

1.4 SUBMITTALS

A. Product Data: For conduit, surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.
2. For handholes and boxes for underground wiring, including the following:

a. Duct entry provisions, including locations and duct sizes.
b. Frame and cover design.

c. Grounding details.
d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Qualification Data: For professional engineer and testing agency.

E. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. 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.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex
7. Maverick Tube Corporation
8. O-Z Gedney; a unit of General Signal
9. Wheatland Tube Company

B. Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit and IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040-inch, minimum.

F. EMT: ANSI C80.3.

G. FMC: Zinc-coated steel or aluminum.

H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel or die-cast and set-screw or compression type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040-inch, with overlapping sleeves protecting threaded joints.

J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NON-METALLIC CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose
3. Arnco Corporation
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products
10. Manhattan/CDT/Cole-Flex
11. RACO; a Hubbell Company
12. Thomas & Betts Corporation

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

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

1. Arnco Corporation
2. Endot Industries Inc.
3. IPEX Inc.
4. Lamson & Sessions; Carlon Electrical Products

B. Description: Comply with UL 2024; flexible type, approved for plenum, riser, general-use installation.

2.4 METAL WIREWAYS

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

1. Cooper B-Line, Inc.
2. Hoffman
3. Square D; Schneider Electric

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type, Screw-cover type, Flanged-and-gasketed type, or as indicated.

E. Finish: Manufacturer's standard enamel finish.

2.5 NON-METALLIC WIREWAYS

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

1. Hoffman
2. Lamson & Sessions; Carlon Electrical Products

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.6 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect and Owner.

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

a. Thomas & Betts Corporation
b. Walker Systems, Inc.; Wiremold Company (The)
c. Wiremold Company (The); Electrical Sales Division

B. Surface Non-metallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect and Owner from manufacturer's entire range.

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

a. Butler Manufacturing Company; Walker Division
b. Enduro Systems, Inc.; Composite Products Division
c. Hubbell Incorporated; Wiring Device-Kellems Division
d. Lamson & Sessions; Carlon Electrical Products
e. Panduit Corp.
f. Walker Systems, Inc.; Wiremold Company (The)
g. Wiremold Company (The); Electrical Sales Division

2.7 BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric
3. Erickson Electrical Equipment Company
4. Hoffman
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division
6. O-Z/Gedney; a unit of General Signal
7. RACO; a Hubbell Company
8. Robroy Industries, Inc.; Enclosure Division
9. Scott Fetzer Co.; Adalet Division
10. Spring City Electrical Manufacturing Company
11. Thomas & Betts Corporation
12. Walker Systems, Inc.; Wiremold Company (The)
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, cast feralloy, Type FD, with gasketed cover.

D. Non-metallic Outlet and Device Boxes: NEMA OS 2.

E. Metal Floor Boxes: Cast iron or sheet metal, fully adjustable, rectangular.

F. Non-metallic Floor Boxes: Non-adjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized cast iron with gasketed cover.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Non-metallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

J. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC." And "TELEPHONE.", or as indicated for each service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 2 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two (2).

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:

a. Armorcast Products Company
b. Carson Industries LLC
c. CDR Systems Corporation
d. NewBasis

C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:

a. Armorcast Products Company
b. Carson Industries LLC
c. Christy Concrete Products
d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one (1) of the following:

a. Carson Industries LLC
b. Christy Concrete Products
c. Nordic Fiberglass, Inc.

2.9 SLEEVES FOR RACEWAYS

A. Comply with requirements in Section 230500 “Common Work Results for Electrical” for sleeves.

2.10 SLEEVE SEALS

A. Comply with requirements in Section 230500 “Common Work Results for Electrical” for sleeve seals.

2.11 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit, IMC.
2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC, RNC, Type EPC-40-PVC, RNC, Type EPC-80-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried unless indicated otherwise.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
6. Application of Handholes and Boxes for Underground Wiring:

a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete enclosures with polymer-concrete frame and cover, SCTE 77, Tier 15 structural load rating.
b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.
c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT, Surface metal raceway, surface non-metallic raceway (where specifically noted).
2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.
d. Auto shop.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: Rigid steel conduit.
6. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway, EMT.
7. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway, EMT.
8. Raceways for Concealed General-Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable raceway, Riser-type, optical fiber/communications cable raceway, Plenum-type, optical fiber/communications cable raceway, EMT.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel or nonmetallic in damp or wet locations.

C. Minimum Raceway Size: ¾-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Section 260529 "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three (3) 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from RNC, Type EPC-40-PVC, to rigid steel conduit, or IMC before rising above the floor.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. ¾-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two (2) 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
   d. Attics: 135 deg F (75 deg C) temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041-inch per foot of length of straight run per deg F (0.06-mm per meter of length of straight run per deg C) of temperature change.

3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

O. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall.

Q. Set metal floor boxes level and flush with finished floor surface.

R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom for pipe less than 6 inches in nominal diameter.
2. Install backfill.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

5. Warning Tape: Bury warning tape approximately 12 inches above direct-buried conduits. Align tape along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from ½-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Comply with requirements in Section 230500 “Common Work Results for Electrical” for sleeves.

3.6 SLEEVE-SEAL INSTALLATION

A. Comply with requirements in Section 230500 “Common Work Results for Electrical” for sleeve seals.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

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. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct bank, and in single duct runs.
2. Handholes and pull boxes.
3. Manholes.

1.3 DEFINITION

A. RNC: Rigid non-metallic conduit.

B. Traffic ways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, pull boxes**,** and other utility structures.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Ladder and/or step details.
5. Grounding details.
6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

C. Shop Drawings for Factory-Fabricated Handholes and Pull Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.

3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

E. Product Certificates: For concrete and steel used in precast concrete manholes, pull boxes, and handholes, comply with ASTM C 858.

F. Qualification Data: For qualified professional engineer and testing agency.

G. Source quality-control reports.

H. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Comply with IEEE C2.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store non-metallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect and Construction Manager no fewer than two (2) days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without the Architect’s and Construction Manager's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and pull boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and pull boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and

elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to five percent (5%) of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NON-METALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems
2. ARNCO Corporation
3. Beck Manufacturing
4. Cantex, Inc.
5. CertainTeed Corp.
6. Condux International, Inc.
7. DCX-CHOL Enterprises, Inc.; ELECSYS Division
8. Electri-Flex Company
9. IPEX Inc.
10. Lamson & Sessions; Carlon Electrical Products
11. Manhattan Wire Products; a Belden company

B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

C. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-120-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

D. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and retained to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.

a. Color: Red dye added to concrete during batching.
b. Mark each plank with "ELECTRIC" in 2-inch-high, 3/8-inch-deep letters.

2.3 PRECAST CONCRETE HANDHOLES AND PULL BOXES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Christy Concrete Products
2. Cretex Concrete Products West, Inc.; Riverton Division
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group
5. Oldcastle Precast Inc.; Utility Vault Division
6. Utility Concrete Products, LLC
7. Wausau Tile Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153 and ASTM A 123.

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or pull box.

1. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing stainless-steel bolts.

a. Cover Hinges: Concealed, with hold-open ratchet assembly.
b. Cover Handle: Recessed.

2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, "ELECTRIC.", "TELEPHONE.", and as indicated for each service.
4. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

a. Extension shall provide increased depth of 12 inches.
b. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.

6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
c. Window openings shall be framed with at least two (2) additional No. 4 steel reinforcing bars in concrete around each opening.

7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

8. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Gray.
2. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Non-skid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering,

    a. "ELECTRIC.", "TELEPHONE.", and as indicated for each service.
    b. Tier level number, indicating that the unit complies with the structural load test for that tier according to SCTE 77.

6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, retained to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Pull Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two (2). Handholes and pull boxes shall comply with the requirements of SCTE 77 Tier 8 and Tier 15 loading.

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

    a. Armorcast Products Company
    b. Carson Industries LLC
    c. CDR Systems Corporation
    d. Hubbell Power Systems; Lenoir City Division
    e. NewBasis

C. Fiberglass Handholes and Pull Boxes with Polymer Concrete Frame and Cover: Complying with SCTE 77 Tier 8 and Tier 15 loading. Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

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

    a. Armorcast Products Company
    b. Carson Industries LLC
    c. Christy Concrete Products
    d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast

D. Fiberglass Handholes and Pull Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete, complying with SCTE 77 Tier 8 and Tier 5 loading.

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

    a. Carson Industries LLC
    b. Christy Concrete Products
    c. Nordic Fiberglass, Inc.

E. High-Density Plastic Pull Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene, complying with SCTE 77 Light Duty loading. The cover shall be polymer concrete.

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

    a. Carson Industries LLC
    b. Nordic Fiberglass, Inc.
    c. Pencell Plastics

2.5 PRECAST MANHOLES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Christy Concrete Products
2. Cretex Concrete Products West, Inc.; Riverton Division
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group
5. Oldcastle Precast Inc.; Utility Vault Division
6. Utility Concrete Products, LLC
7. Wausau Tile Inc.

B. Comply with ASTM C 858, with structural design loading as specified in "Underground Enclosure Application" Article, and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
c. Window openings shall be framed with at least two (2) additional No. 4 steel reinforcing bars in concrete around each opening.

2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size shall match fittings to duct or conduit to be terminated.
b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

C. Concrete Knockout Panels: 1½ to 2 inches thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.6 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C 858 and with Section 033000 "Cast-in-Place Concrete."

1. Concrete shall have a minimum compressive strength of 3000 psi.

C. Structural Design Loading: As specified in "Underground Enclosure Application" Article.

2.7 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bilco Company (The)
2. Campbell Foundry Company
3. Christy Concrete Products
4. Cretex Concrete Products West, Inc.; Riverton Division
5. East Jordan Iron Works
6. Elmhurst-Chicago Stone Co.
7. Hubbell Power Systems; Lenoir City Division
8. McKinley Iron Works
9. Neenah Foundry Company
10. NewBasis
11. Oldcastle Precast Group
12. Oldcastle Precast Inc.; Utility Vault Division
13. Osburn Associates, Inc.
14. Pennsylvania Insert Corporation
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC

17. Wausau Tile Inc.

B. Ferrous metal hardware, where indicated, shall be hot-dip galvanized complying with ASTM A 153 and A 123.

C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Retained to suit system.

a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
c. Legend: "SIGNAL" for communications, data, and telephone duct systems.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.

D. Manhole Sump Frame and Grate: ASTM A 48, Class 30B, gray cast iron.

E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

F. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1¼-inch-diameter eye, rated 2500-lbf minimum tension.

G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; ½-inch ID by 2¾ inches deep, flared to 1¼ inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with ½-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

J. Cable Rack Assembly: Steel, hot-dip galvanized except insulators.

1. Stanchions: T-section or channel; 2¼-inch nominal size; punched with 14 holes on 1½-inch centers for cable-arm attachment.
2. Arms: 1½ inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

K. Cable Rack Assembly: Nonmetallic. Components fabricated from non-conductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of nine (9) holes for arm attachment.
2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. The top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

L. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperatures of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

M. Fixed Manhole Ladders: Arranged for attachment to wall of manhole. Ladder and mounting brackets and braces shall be fabricated from non-conductive, structural-grade, fiberglass-reinforced resin.

N. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches. One (1) required.

O. Cover Hooks: Heavy duty, designed for lifts of 60 lbf and greater. Two (2) required.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull Box Prototype Test: Test prototypes of manholes and pull boxes for compliance with SCTE 77. Strength tests shall be for specified Tier ratings of products supplied.

1. Testing Agency: Owner will engage a qualified testing agency to evaluate non-concrete handholes and pull boxes.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

3.2 CORROSION PROTECTION

A. Aluminum shall not be installed in contact with earth or concrete.

3.3 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40 PVC, in direct-buried duct bank unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

E. Underground Ducts Crossing Driveways, Roadways, and Railroads: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.4 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Pull Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 or Tier 22 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf "Light-Duty" vertical loading.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.5 EARTHWORK

A. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.6 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two (2) manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 25 ft. both horizontally and vertically, at other locations unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 ft. from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 ft. outside the building wall without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260500 "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than five (5) spacers per 20 ft. of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie the entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
    b. If more than one (1) pour is necessary, terminate each pour in a vertical plane and install ¾-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to the center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

10. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than five (5) spacers per 20 ft. of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms for pipes less than 6 inches in nominal diameter.
4. Install backfill.

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction.
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches below finished grade unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

11. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.7 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND PULL BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1½- to 2- inches-thick, arranged as indicated.
3. Cast-in-place concrete, formwork, and reinforcement are specified in Section 033000 "Cast-in-Place Concrete."

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below the frost line, below grade.

4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three (3) days. Waterproofing materials and installation are specified in Division 07. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three (3) days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two (2) anchors for each cable stanchion.

J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.8 INSTALLATION OF HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and pull boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level 6-inch-thick bed of crushed stone or gravel, graded from ½-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: Set so cover surface will be flush with finished grade.

D. Install handholes and pull boxes with bottom below the frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Retain arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, twenty-eight (28) day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

3.9 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to eighty percent (80%) fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.11 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on 20-inch centers.

D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch-wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

H. Metal Tags: Brass or aluminum, 2-by-2-by-0.05-inch, with stamped legend, punched for use with self-locking cable tie fastener.

I. Write-On Tags: Polyester tag, 0.015-inch-thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high letters on 20-inch centers.

D. Self-Adhesive Vinyl Labels: Pre-printed, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Pre-printed, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2-by-2-by-0.05-inch, with stamped legend, punched for use with self-locking cable tie fastener.

D. Write-On Tags: Polyester tag, 0.015-inch-thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

E. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Pre-printed, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

F. Write-On Tags: Polyester tag, 0.015-inch-thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

B. Furnish and install tape at location in accordance with NEC 110.26 for all electrical distribution equipment.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one (1) side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb./1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multi-color, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Pre-printed aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. ¼-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, non-fading, pre-printed, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. ¼-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16-inch-thick for signs up to 20 sq. inches and 1/8-inch-thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8-inch.

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8-inch.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. The minimum letter height shall be 1-inch.

2.10 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16-inch.
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one-piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16-inch.
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one-piece, self-locking.

1. Minimum Width: 3/16-inch.
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.11 DATA RECEPTACLES

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. It should read “DATA ONLY”. Minimum letter height shall be 3/8-inch.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8-inch.

2.12 RECEPTACLES ON EMERGENCY POWER

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in orange, by thermal transfer or equivalent process. Minimum letter height shall be 3/8-inch. Overlay shall provide a weatherproof and UV-resistant seal for label. Install orange label with receptacle device for identification.

2.13 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify the identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.2 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at 30-foot maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 30-foot maximum intervals.

D. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Standby Power.
3. Normal Power.

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two (2) turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

F. Power-Circuit Conductor Identification, more than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags, nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

G. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

H. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

K. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.
b. Controls with external control power connections.

M. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

N. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer and load shedding.

O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Adhesive film label. Unless otherwise indicated, provide a single line of text with ½-inch-high letters on 1½-inch-high label; where two (2) lines of text are required, use labels 2 inches high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label. Stenciled legend 4 inches high.
c. Elevated Components: Increase the sizes of labels and letters to those appropriate for viewing from the floor.
d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive and engraved laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Switchgear.
e. Switchboards.
f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
g. Emergency system boxes and enclosures.
h. Enclosed switches.
i. Enclosed circuit breakers.
j. Enclosed controllers.
k. Variable-speed controllers.
l. Push-button stations.
m. Power transfer equipment.
n. Contactors.
o. Remote-controlled switches, dimmer modules, and control devices.
p. Power-generating units.
q. Monitoring and control equipment.

END OF SECTION 260553

SECTION 260572 - SHORT-CIRCUIT STUDIES

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 a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices (new equipment only).

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

a. Short-circuit study input data, including completed computer program input data sheets.
b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
2. The following are from the Short-Circuit Study Report:

a. Final one-line diagram.
b. Final Short-Circuit Study Report.
c. Short-circuit study data files.
d. Power system data.

1.7 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Comply with IEEE 399 and IEEE 551.

1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

B. The computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
6. Derating factors and environmental conditions.
7. Any revisions to electrical equipment required by the study.

D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.

3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Calculated asymmetrical fault currents:

        1) Based on fault-point X/R ratio.
        2) Based on calculated symmetrical value multiplied by 1.6.
        3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. No AC Decrement (NACD) ratio.
    e. Equivalent impedance.
    f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

A. Obtain all data necessary for conducting the study.

1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
8. Motor horsepower and NEMA MG 1 code letter designation.
9. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
10. Derating factors.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base the study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings (new equipment only).

E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

I. Include in the report identification of any protective device applied outside its capacity.

J. Study is required for main service equipment and panelboards. Where the main equipment feeds downstream distribution that is existing to remain, the study is only required to extend to the first existing device in a string.

END OF SECTION 260572

SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Qualification Data: For qualified testing agency.

D. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary

HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

   a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
   b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

   1. Notify Architect and Construction Manager Owner no fewer than two (2) days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without the Architect's and Construction Manager's written permission.
   3. Comply with NFPA 70E.

1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

   1. Warranty Period: Five (5) years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Keys: Two (2) spares for each type of panelboard cabinet lock.
   2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two (2) spares for each panelboard.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250
b. Outdoor Locations: NEMA 250, Type 3R.
c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5 or Type 12.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.

7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, ninety-eight percent (98%) conductivity.

a. Plating shall run entire length of bus.
b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, ninety-eight percent (98%) conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one (1) or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed, and labeled for series-connected short-circuit rating by an NRTL.

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two (2) latches, keyed alike.

D. Mains: Circuit breaker, Fused switch, and Lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

G. Contactors in Main Bus: NEMA ICS 2, Class A, electrically and/or mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 120-V branch circuit.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, electrically and/or mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 120-V branch circuit.

F. Doors: Concealed hinges; Door-in-door style, secured with flush latch with tumbler lock; keyed alike.

G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Electronic trip setting for circuit-breaker frame sizes 200 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Compression and Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Shunt Trip: 120 and/or 24 V trip coil energized from separate circuit, set to trip at seventy-five percent (75%) of rated voltage.
    f. Undervoltage Trip: Set to operate at thirty-five to seventy-five percent (35-75%) of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
    g. Auxiliary Contacts: One (1) SPDT switch with "a" and "b" contacts; "a" contact's mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
    h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
    i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
    j. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
    k. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
    l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
    m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
3. Auxiliary Contacts: One (1) normally open and normally closed contact(s) that operate with switch handle operation.

2.5 PANELBOARD SUPPRESSORS (WHEN INDICATED ON DRAWINGS)

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. Current Technology; a subsidiary of Danahar Corporation
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution
4. Liebert Corporation
5. Siemens Energy & Automation, Inc.
6. Square D; a brand of Schneider Electric

B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:

a. LED indicator lights for power and protection status.
b. Audible alarm, with silencing switch, to indicate when protection has failed.
c. One (1) set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and/or NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and/or NEMA PB 1.1.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. Mount the panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four (4) 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four (4) 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace them with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard eleven (11) months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.

B. Load Balancing: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding twenty percent (20%) between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

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 equipment for electricity metering by utility company and electricity metering by Owner.

1.3 DEFINITIONS

A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

B. PC: Personal computer.

1.4 SUBMITTALS

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

B. Shop Drawings: For electricity-metering equipment.

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

C. Field quality-control reports.

D. Operation and Maintenance Data. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.
2. Software licenses.
3. Software service agreement.
4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect and Construction Manager no fewer than two (2) days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without the Architect’s and Construction Manager's written permission.

1.8 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include the operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide thirty (30) days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Meters will be furnished by utility company.

B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

C. Meter Sockets: Comply with requirements of electrical-power utility company.

D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

2.2 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. E-Mon; a division of Hunt Power
2. National Meter Industries
3. Osaki Meter Sales, Inc.
4. Square D; a brand of Schneider Electric

B. General Requirements for Owner's Meters:

1. Comply with UL 1244.
2. Meters used for billing shall have an accuracy of one percent (1%) of reading, complying with requirements in ANSI C12.20.
3. Enclosure: NEMA 250, Type 3R minimum, with hasp for padlocking or sealing.
4. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

    a. Type: Split and solid core.

7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
8. Building Automation System (BAS) Interface: One (1) digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

C. Kilowatt-hour Meter: Electronic single- and three-phase meters, measuring electricity used.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25-inch-high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a non-volatile memory, until reset.

D. Kilowatt-hour/Demand Meter: Electronic single- and three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25-inch-high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a non-volatile memory, until reset.

E. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

F. Software: PC based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing.

1. Utility Cost Allocation: Automatically import energy-usage records to allocate energy costs for the following:

    a. At least fifteen (15) departments.
    b. At least thirty (30) tenants.
    c. At least five (5) processes.
    d. At least five (5) buildings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

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. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

C. Samples: One (1) for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one (1) source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one (1) source.

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 NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper)
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell)
3. Leviton Mfg. Company Inc. (Leviton)
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour)

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

a. Cooper; **5351** (single), **5352** (duplex)
b. Hubbell; **HBL5351** (single), **CR5352** (duplex)
c. Leviton; **5891** (single), **5352** (duplex)
d. Pass & Seymour; **5381** (single), **5352** (duplex)

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

a. Hubbell; **CR 5253IG**
b. Leviton; **5362-IG**
c. Pass & Seymour; **IG6300**

2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

    a. Cooper; **TR8300**
    b. Hubbell; **HBL8300SG**
    c. Leviton; **8300-SGG**
    d. Pass & Seymour; **63H**

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

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

    a. Cooper; **GF20**
    b. Pass & Seymour; **2084**

2.4 TVSS RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.

1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex TVSS Convenience Receptacles:

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

    a. Cooper; **5362BLS**
    b. Hubbell; **HBL5362SA**
    c. Leviton; **5380**

2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

C. Isolated-Ground, Duplex Convenience Receptacles:

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

    a. Cooper; **IG5362BLS**
    b. Hubbell; **IG5362SA**
    c. Leviton; **5380-IG**

2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the

device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

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

a. Cooper; **L520R**
b. Hubbell; **HBL2310**
c. Leviton; **2310**
d. Pass & Seymour; **L520-R**

2. Refer to floor plans for other configurations required for project.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:

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

a. Hubbell; **IG2310**
b. Leviton; **2310-IG**

2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.6 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of thirty percent (30%).
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: As selected by Architect and Owner from manufacturer’s entire range, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. Isolated-Ground Receptacles: Orange and/or as specified above, with orange triangle on face.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pig tailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to ¾ of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
10. Install GFCI devices in all wet locations.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

1. Receptacles and Switches: Identify panelboard and circuit number from which served. Use self-adhesive labels with black lettering on white field mounted on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of six percent (6%) or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace them with new ones, and retest as specified above.

C. Test straight blade convenience outlets in patient-care areas and hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

END OF SECTION 262726

SECTION 262813 - FUSES

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. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, enclosed controllers, and motor-control centers.
2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches.
3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
4. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to ten percent (10%) of quantity installed for each size and type, but no fewer than two (2) of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 PLUG FUSES

A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.4 PLUG-FUSE ADAPTERS

A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuse holders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Feeders: Class J, fast acting.
2. Motor Branch Circuits: Class RK1, time delay.
3. Other Branch Circuits: Class J, fast acting.
4. Control Circuits: Class CC, fast acting.

B. Plug Fuses:

1. Motor Branch Circuits: Edison-base type, single-element time delay.
2. Other Branch Circuits: Edison-base type, single-element fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install plug-fuse adapters in Edison-base fuse holders and sockets. Ensure that adapters are irremovable once installed.

C. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Non-Fusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit on translucent log-log graph paper.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect and Construction Manager no fewer than seven (7) days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Architect and Construction Manager written permission.
4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to ten percent (10%) of quantity installed for each size and type, but no fewer than three (3) of each size and type.
2. Fuse Pullers: Two (2) for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Type HD, Heavy Duty, Single Throw, 600-V ac and 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three (3) padlocks and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six-Pole, Single Throw, 600-V ac and 240-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three (3) padlocks and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 600-V ac and 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses,

lockable handle with capability to accept three (3) padlocks and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: Two (2) NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical and/or Compression type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.

2.2 NON-FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Type HD, Heavy Duty, Single Throw, 600-V ac and 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three (3) padlocks and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac and 240-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three (3) padlocks and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 600-V ac and 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three (3) padlocks and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Two (2) NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical and/or Compression type, suitable for number, size, and conductor material.

2.3 RECEPTACLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 600-V ac and 240-V ac, 100 A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate indicated fuses; lockable handle with capability to accept three (3) padlocks; interlocked with cover in closed position.

C. Type HD, Heavy-Duty, Single-Throw Non-Fusible Switch: 600-V ac and 240-V ac, 100 A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three (3) padlocks; interlocked with cover in closed position.

D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

E. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

2.4 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.
3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three (3) padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:

1. Oil-tight key switch for key-to-test function.
2. Oil-tight green ON pilot light.
3. Isolated neutral lug; two hundred percent (200%) rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.

6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac and/or 24-V dc coil voltage.
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical and/or Compression type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings,

push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at thirty-five to seventy-five percent (35-75%) of rated voltage without intentional time delay.
7. Auxiliary Contacts: Two (2) SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. Alarm Switch: One (1) NC contact that operates only when circuit breaker has tripped.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic and/or ground-fault trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Provide remote control for on, off, and reset operations.

2.6 MOLDED-CASE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Mechanical and/or Compression type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at thirty-five to seventy-five percent (35-75%) of rated voltage without intentional time delay.
6. Auxiliary Contacts: Two (2) SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
7. Alarm Switch: One (1) NC contact that operates only when switch has tripped.
8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
10. Electrical Operator: Provide remote control for on, off, and reset operations.
11. Accessory Control Power Voltage: Integrally mounted, self-powered; 120-V ac and 24-V dc.

2.7 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen and/or Wash-Down Areas: NEMA 250, Type 4X.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace them with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker eleven (11) months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified.

END OF SECTION 262816

SECTION 265119 - LED INTERIOR LIGHTING

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. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79 and IES LM-80.

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by the manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each luminaire housing supply at submittal stage a paint chip of the fixture color as specified on the fixture schedule for approval.

D. For luminaires and lamps ref to Product Schedule: Shipping carton/box designation to be clearly marked with same designations as indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lighting luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
4. Structural members to which equipment and or luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:

a. Other luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Ceiling-mounted projectors.

7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of luminaire.

F. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and/or manufacturers' model numbers.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps (Arrays) + Driver(s): One (1) spare for every twenty-five (25) of each type and rating installed. Furnish at least one (1) of each type.
2. Diffusers and Lenses: One (1) for every ten (10) of each type and rating installed. Furnish at least one (1) of each type.
3. Globes and Guards: One (1) for every ten (10) of each type and rating installed. Furnish at least one (1) of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Mockups: For interior lighting luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

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

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Recessed Fixtures: Comply with NEMA LE 4.

E. Bulb shape complying with ANSI C79.1.

F. Lamp base complying with ANSI C81.61 (where applicable).

G. CRI of minimum 80. CCT of 4000K.

H. Rated lamp life of 50,000 hours.

I. Lamps dimmable from one hundred to zero percent (100-0%) of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: 120-277 VAC.

1. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

L. Housings:

1. Extruded aluminum or aluminum housing and heat sink.
2. Finish approval by Architect and Owner from manufacturer’s entire range.

M. Manufacturer – Basis-of-Design:

1. See Fixture Schedule on Drawings.

2.2 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Acrylic Diffusers: One hundred percent (100%) virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

D. Housings:

1. Extruded aluminum or aluminum housing and heat sink.
2. Powder-coat finish.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.3 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: ½-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641, Class 3, soft temper, zinc-coated steel, 12-gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of one hundred twenty-five percent (125%) of luminaire weight and vertical force of four hundred percent (400%) of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four (4) points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls or bracing detail if shown on Drawings.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two (2) 5/32-inch diameter aircraft cable supports adjustable to 120 inches in length.
2. Pendant mount requirements per fixture schedule model number.
3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one (1) point and rod or wire support for suspension for each unit length of luminaire chassis, including one (1) at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four (4) locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two (2) visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119