SPECIFICATIONS

CREC – Academy of Aerospace & Engineering Elementary School

Rocky Hill, Connecticut

State Project No. 241-0105 MAG/N/PS

Phase I – General Construction

January 5, 2018

Issued for Bid: February 26, 2018

Architects Project No. 2016-022A

Architect
Friar Architecture Inc.
21 Talcott Notch Road
Farmington, CT 06032

Construction Manager
Downes Construction Company LLC
200 Stanley Street
New Britain, CT 06050

Structural Engineer
Perrone & Zajda, LLC
630 Main Street, Suite 2
Cromwell, CT 06416

Landscape Architect
Martinez Couch & Associates, LLC
1084 Cromwell Avenue
Rocky Hill, CT 06067

Mechanical/Electrical Engineer
Consulting Engineering Services
811 Middle Street
Middletown, CT 06457

Civil Engineer
Martinez Couch & Associates, LLC
1084 Cromwell Avenue
Rocky Hill, CT 06067

VOLUME 2 OF 2
DIVISIONS 21 - 33

PROJECT MANUAL		**Number of Pages**
Refer to Invitation to Bid - Downes Construction Project Manual		
SPECIFICATIONS		
VOLUME 1 OF 2		
000110	TABLE OF CONTENTS	7
000115	LIST OF DRAWINGS	7
DIVISION 00 – INFORMATION AVAILABLE TO BIDDERS		
003132	GEOTECHNICAL DATA	2
	GEOTECHNICAL STUDY	23
DIVISION 01 - GENERAL REQUIREMENTS		
011000	SUMMARY	7
012300	ALTERNATES	2
012600	CONTRACT MODIFICATION PROCEDURES	3
012900	PAYMENT PROCEDURES	5
013100	PROJECT MANAGEMENT AND COORDINATION	10
	CAD FILES AGREEMENT	1
	REVIT FILES AGREEMENT	1
013200	CONSTRUCTION PROGRESS DOCUMENTATION	9
013300	SUBMITTAL PROCEDURES	13
014000	QUALITY REQUIREMENTS	8
014200	REFERENCES	2
015000	TEMPORARY FACILITIES AND CONTROLS	9
	PROJECT SIGN	1
016000	PRODUCT REQUIREMENTS	9
017300	EXECUTION	7
017329	CUTTING AND PATCHING	4
017419	CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL	7
017700	CLOSEOUT PROCEDURES	6
017823	OPERATION AND MAINTENANCE DATA	8
017839	PROJECT RECORD DOCUMENTS	4
017900	DEMONSTRATION AND TRAINING	6
018113	SUSTAINABLE DESIGN REQUIREMENTS	7
	PROPOSED PROJECT STRATEGY CHECKLIST	1
018119	INDOOR AIR QUALITY REQUIREMENTS	7
019112	COMMISSIONING OF BUILDING ENCLOSURE	5
019113	COMMISSIONING REQUIREMENTS	12
DIVISION 02 – EXISTING CONDITIONS		
Not included in Specification		
DIVISION 03 - CONCRETE		
030510	CONCRETE MOISTURE VAPOR REDUCTION ADMIXTURE	7
031000	CONCRETE FORMWORK	3
032000	CONCRETE REINFORCEMENT – BUILDING	3

033000	CAST-IN-PLACE CONCRETE - BUILDING	12
033053	MISCELLANEOUS CAST-IN-PLACE CONCRETE	9
034500	PRECAST ARCHITECTURAL CONCRETE	12

DIVISION 04 - MASONRY

042000	UNIT MASONRY	27
044313.16	ADHERED STONE MASONRY VENEER	10

DIVISION 05 - METALS

051200	STRUCTURAL STEEL FRAMING	4
052100	STEEL JOIST FRAMING	2
053000	METAL DECK	2
054043	COLD-FORMED METAL RAINSCREEN ASSEMBLY	10
055000	METAL FABRICATIONS	10
055100	METAL STAIRS	9
055213	PIPE AND TUBE RAILINGS	10

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES

061053	MISCELLANEOUS ROUGH CARPENTRY	7
061600	SHEATHING	6
064023	INTERIOR ARCHITECTURAL WOODWORK	14

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

071900	WATER REPELLANTS	5
072100	THERMAL INSULATION	9
072726	FLUID-APPLIED MEMBRANE AIR BARRIERS	10
072729	WATER-RESISTIVE AIR-BARRIER MEMBRANES	8
074213.13	FORMED METAL WALL PANELS	13
074213.53	METAL SOFFIT PANELS	8
075416	THERMOPLASTIC (TPA) MEMBRANE ROOFING	13
075423	THERMOPLASTIC POLYOLEFIN (TPO) ROOFING	13
076200	SHEET METAL FLASHING AND TRIM	9
077100	ROOF SPECIALTIES	8
077200	ROOF ACCESSORIES	6
078413	PENETRATION FIRESTOPPING	9
078446	FIRE-RESISTIVE JOINT SYSTEMS	7
079200	JOINT SEALANTS	11
079201	SPRAY FOAM SEALANTS	3
079500	EXPANSION CONTROL	8

DIVISION 08 – OPENINGS

080610	OPENINGS SCHEDULE	1
	OPENINGS SCHEDULE	24
081113	HOLLOW METAL DOORS AND FRAMES	10
081416	FLUSH WOOD DOORS	7
083113	ACCESS DOORS AND FRAMES	5

083326	OVERHEAD COILING GRILLES	9
083513	FOLDING DOORS	7
084113	ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS	13
084126	ALL-GLASS STOREFRONTS	5
084413	GLAZED ALUMINUM CURTAIN WALLS	11
084523	FIBERGLASS-SANDWICH-PANEL ASSEMBLIES	10
087100	DOOR HARDWARE	39
088000	GLAZING	16
088300	MIRRORS	6
088400	PLASTIC GLAZING	8
088713	GLAZING FILMS	3
089119	FIXED LOUVERS	6

DIVISION 09 – FINISHES

092116	GYPSUM BOARD ASSEMBLIES	20
092116.23	GYPSUM BOARD SHAFT WALL ASSEMBLIES	7
093100	TILING	15
095113	ACOUSTICAL PANEL CEILINGS	11
096283	STRUCTURAL GLASS FLOORING	4
096513	RESILIENT BASE AND ACCESSORIES	7
096516	RESILIENT SHEET FLOORING	8
096519	RESILIENT TILE FLOORING	9
096566	RESILIENT ATHLETIC FLOORING	8
096813	TILE CARPETING	9
096816	SHEET CARPETING	8
097200	WALL COVERINGS	6
098413	FIXED SOUND-ABSORPTIVE PANELS	6
099100	PAINTING	14
099666	WATER VAPOR EMISSION CONTROL SYSTEM	6

DIVISION 10 - SPECIALTIES

101100	VISUAL DISPLAY SURFACES	8
101200	DISPLAY CASES	6
101400	SIGNAGE	10
101426	POST AND PANEL/PYLON SIGNAGE	3
101433	PHOTOLUMINESCENT EGRESS PATH MARKING SYSTEM	3
102113	TOILET COMPARTMENTS	5
102123	CUBICLES	5
102226	OPERABLE PARTITIONS	9
102239	VERTICALLY RETRACTABLE ACOUSTIC WALL	9
102600	WALL PROTECTION	5
102800	TOILET AND BATH ACCESSORIES	6
104116	EMERGENCY KEY CABINETS	3
107500	FLAGPOLES	5

DIVISION 11 - EQUIPMENT

113100	RESIDENTIAL APPLIANCES	8
114000	FOOD SERVICE EQUIPMENT (Refer to Appendix)	
115213	PROJECTION SCREENS	4
116143	STAGE CURTAINS	7
116623	GYMNASIUM EQUIPMENT	10
116653	GYMNASIUM DIVIDERS	6
116800	PLAY FIELD EQUIPMENT AND STRUCTURES	8
116833	ATHLETIC FIELD EQUIPMENT	5
119000	MISCELLANEOUS EQUIPMENT	5

DIVISION 12 – FURNISHINGS

122113	HORIZONTAL LOUVER BLINDS	6
122413	ROLLER WINDOW SHADES	13
123551	MUSIC EDUCATION STORAGE SYSTEMS	8
123661	SIMULATED STONE COUNTERTOPS	6
129300	SITE FURNISHINGS	8

DIVISION 13 – SPECIAL CONSTRUCTION

Not included in Specification

DIVISION 14 – CONVEYING EQUIPMENT

142100	ELECTRIC TRACTION ELEVATORS	12

VOLUME 2 OF 2

000110	TABLE OF CONTENTS	7
000115	LIST OF DRAWINGS	7

DIVISION 21 – FIRE SUPPRESSION

210500	COMMON WORK RESULTS FOR FIRE SUPPRESSION	11
210516	EXPANSION FITTINGS AND LOOPS FOR FIRE-SUPPRESSION PIPING	6
210548	VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT	11
210800	COMMISSIONING OF FIRE SUPPRESSION	6
211313	WET-PIPE SPRINKLER SYSTEMS	9

DIVISION 22 – PLUMBING

220400	GENERAL CONDITIONS FOR PLUMBING TRADES	20
220500	COMMON WORK RESULTS FOR PLUMBING	3
220503	PIPES AND TUBES FOR PLUMBING PIPING AND EQUIPMENT	12
220516	EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING	6
220523	GENERAL-DUTY VALVES FOR PLUMBING PIPING	8
220529	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT	11
220548	VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT	12
220553	IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT	6
220700	PLUMBING INSULATION	11
220800	COMMISSIONING OF PLUMBING	7

221113	FACILITY WATER DISTRIBUTION PIPING	18
221123	FACILITY NATURAL GAS PIPING	11
221313	FACILITY SANITARY SEWERS	20
223000	PLUMBING SPECIALTIES	11
223400	FUEL-FIRED DOMESTIC WATER HEATERS	6
224000	PLUMBING FIXTURES	9

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

230400	GENERAL CONDITIONS FOR MECHANICAL TRADES	21
230513	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT	3
230516	EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING	6
230523	GENERAL-DUTY VALVES FOR HVAC PIPING	5
230529	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT	7
230548	VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT	19
230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT	5
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC	9
230700	HVAC INSULATION	10
230800	COMMISSIONING OF HVAC SYSTEMS	8
230900	INSTRUMENTATION AND CONTROL FOR HVAC	34
230950	FACILITY MONITORING SYSTEM	18
230993	SEQUENCE OF OPERATIONS FOR HVAC CONTROLS	14
232113	HYDRONIC PIPING	10
232116	HYDRONIC PIPING SPECIALTIES	10
232123	HYDRONIC PUMPS	4
232300	REFRIGERANT PIPING	5
232500	HVAC WATER TREATMENT	2
233100	HVAC DUCTS AND CASINGS	8
233300	AIR DUCT ACCESSORIES	9
233303	SOUND ATTENUATORS	6
233400	HVAC FANS	5
233606	AIR TERMINAL UNITS	4
233700	AIR OUTLETS AND INLETS	4
235232	HOT WATER CONDENSING BOILERS	7
236411	PACKAGE WATER CHILLERS – RECIPROCATING, SCROLL AND SCREW	7
237413	OUTDOOR CENTRAL STATION AIR-HANDLING UNITS	10
238200	CONVECTION HEATING AND COOLING UNITS	5

DIVISION 26 – ELECTRICAL

260400	GENERAL CONDITIONS FOR ELECTRICAL TRADES	19
260503	EQUIPMENT WIRING CONNECTIONS	3
260519	BUILDING WIRE AND CABLE	6
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	5
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	6
260533	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS	8
260534	FLOOR BOXES FOR ELECTRICAL SYSTEMS	5

260536	CABLE TRAYS FOR ELECTRICAL SYSTEMS	3
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS	4
260573	OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY	5
260800	COMMISSIONING OF ELECTRICAL SYSTEMS	6
260923	LIGHTING CONTROL DEVICES	5
260943	NETWORK LIGHTING CONTROLS	13
262200	LOW-VOLTAGE TRANSFORMERS	4
262413	SWITCHBOARDS	7
262416	PANELBOARDS	6
262726	WIRING DEVICES	4
232813	FUSES	2
262819	ENCLOSED SWITCHES	3
262826	ENCLOSED TRANSFER SWITCHES	4
262913	ENCLOSED CONTROLLERS	4
263213	ENGINE GENERATORS	6
264100	FACILITY LIGHTNING PROTECTION	3
264500	PHOTOVOLTAIC SYSTEM	12
265100	INTERIOR LIGHTING	9
265200	EMERGENCY LIGHTING	3
265562	THEATRICAL LIGHTING AND CONTROLS	21
265600	EXTERIOR LIGHTING	4

DIVISION 27 – COMMUNICATIONS

270526	GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS	4
270529	HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS	6
270533	CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS	8
270536	CABLE TRAYS FOR COMMUNICATIONS SYSTEMS	3
270553	IDENTIFICATION FOR COMMUNICATIONS SYSTEMS	4
271100	COMMUNICATIONS EQUIPMENT ROOM FITTINGS	7
271300	COMMUNICATIONS BACKBONE CABLING	14
271500	COMMUNICATIONS HORIZONTAL CABLING	14
275116	PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS	23
275313	CLOCK SYSTEMS	9

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

280513	CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY	7
280529	HANGERS AND SUPPORTS FOR ELECTRONIC SAFETY AND SECURITY	6
280533	CONDUITS AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY	8
280553	IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY	4
281300	ACCESS CONTROL	39
281600	INTRUSION DETECTION	14
282300	VIDEO SURVEILLANCE	15
283100	FIRE DETECTION AND ALARM	21

DIVISION 31 – EARTHWORK

311000	SITE CLEARING	11
312000	EARTH MOVING	16
312319	DEWATERING	5
315000	EXCAVATION SUPPORT AND PROTECTION	5

DIVISION 32 – EXTERIOR IMPROVEMENTS

321216	ASPHALT PAVING	14
321313	CONCRETE PAVING	14
321373	CONCRETE PAVING JOINT SEALANTS	5
323113	CHAIN LINK FENCES AND GATES	8
323119	DECORATIVE METAL FENCES AND GATES	8
323121	ALUMINUM LOUVER FENCING AND GATES	4
323215	PRECAST MODULAR BLOCK GRAVITY RETAINING WALL	15
328400	PLANTING IRRIGATION	20
329113	SOIL PREPARATION	14
329200	TURF AND GRASSES	9
329300	PLANTS	15

DIVISION 33 – UTILITIES

334000	STORM UTILITY DRAINAGE PIPING	14
334600	SUBDRAINAGE	4
337102	UNDERGROUND ELECTRICAL DISTRIBUTION	21
337119	ELECTRICAL UNDERGROUND DUCTS AND HANDHOLES	5
337900	SITE GROUNDING	4

APPENDIX

114000	FOOD SERVICE EQUIPMENT	351

END OF SECTION 000110

LIST OF DRAWINGS
VOLUME I OF II

REFERENCE

R1.1	REFERENCE SHEET
R1.2	WALL TYPES & U.L. RATINGS
R1.3	CODE INFORMATION
R1.4	FIRST FLOOR EGRESS PLAN
R1.5	SECOND FLOOR EGRESS PLAN

CIVIL

CD-101	SITE DEMOLITION PLAN
C-101-SEC	SEDIMENT AND EROSION CONTROL PLAN - PHASE 1
C-102-SEC	SEDIMENT AND EROSION CONTROL PLAN - PHASE2
C-103-SEC	SEDIMENT AND EROSION CONTROL PLAN - PHASE 3
CS-100	SITE LAYOUT KEY MAP
CS-101	SITE LAYOUT AND SIGNAGE - 1
CS-102	SITE LAYOUT AND SIGNAGE - 2
CS-103	SITE LAYOUT AND SIGNAGE - 3
CS-104	SITE LAYOUT AND SIGNAGE - 4
CS-101-ADA	SITE PLAN ADA ACCESSIBILITY - 1
CS-102-ADA	SITE PLAN ADA ACCESSIBILITY - 2
CS-103-ADA	SITE PLAN ADA ACCESSIBILITY - 3
CS-104-ADA	SITE PLAN ADA ACCESSIBILITY - 4
CG-101	SITE GRADING AND DRAINAGE PLAN - 1
CG-102	SITE GRADING AND DRAINAGE PLAN - 2
CG-103	SITE GRADING AND DRAINAGE PLAN - 3
CG-104	SITE GRADING AND DRAINAGE PLAN - 4
CU-101	SITE UTILITY PLAN - 1
CU-102	SITE UTILITY PLAN - 2
CU-103	SITE UTILITY PLAN - 3
CU-104	SITE UTILITY PLAN - 4
CU-301	MDC DEVELOPERS PERMIT AGREEMENT PLAN AND PROFILE - 1
CU-302	MDC DEVELOPERS PERMIT AGREEMENT PLAN AND PROFILE - 2
C-601	DETAILS
C-602	DETAILS
C-603	DETAILS
C-604	DETAILS
C-605	DETAILS
C-606	DETAILS
C-607	DETAILS
C-608	DETAILS
C-609	DETAILS
C-610	DETAILS
C-611	DETAILS
C-612	DETAILS
C-613	DETAILS
C-614	DETAILS
C-615	DETAILS
C-616	DETAILS

LANDSCAPE

L-101	SITE PLANTING PLAN - 1
L-102	SITE PLANTING PLAN - 2
L-103	SITE PLANTING PLAN - 3
L-104	SITE PLANTING PLAN - 4
L-601	DETAILS
L-602	DETAILS
IP-101	IRRIGATION PLAN - 1
IP-102	IRRIGATION PLAN - 2

ARCHITECTURE

A0.1	FIRST FLOOR PLAN KEY PLAN
A0.2	SECOND FLOOR KEY PLAN
A1.1	FIRST FLOOR PLAN - AREA A
A1.2	FIRST FLOOR PLAN - AREA B
A1.3	FIRST FLOOR PLAN - AREA C
A1.4	FIRST FLOOR PLAN - AREA D
A1.5	SECOND FLOOR PLAN - AREA A
A1.6	SECOND FLOOR PLAN - AREAS B & C
A2.1	ROOF PLAN
A2.2	ROOF DETAILS
A2.3	ROOF DETAILS
A2.4	ROOF DETAILS
A3.1	BUILDING ELEVATIONS
A3.2	EXTERIOR ELEVATIONS - AREA A
A3.3	EXTERIOR ELEVATIONS - AREA A
A3.4	EXTERIOR ELEVATIONS - AREA B
A3.5	EXTERIOR ELEVATIONS - AREA B
A3.6	EXTERIOR ELEVATIONS - AREA C
A3.7	EXTERIOR ELEVATIONS - AREA D
A3.8	EXTERIOR ELEVATIONS - AREA D
A4.1	BUILDING SECTIONS - AREAS A, B & C
A4.2	BUILDING SECTIONS - AREA D
A5.1	WALL SECTIONS - AREAS A & B
A5.2	WALL SECTIONS - AREA C
A5.3	WALL SECTIONS - AREA C
A5.4	WALL SECTIONS - AREAS C & D
A5.5	WALL SECTIONS - AREA D
A5.6	WALL SECTIONS - AREA D
A5.7	WALL SECTIONS - AREA D
A5.8	WALL SECTIONS - AREA D
A5.9	WALL SECTIONS - AREA D
A5.10	WALL SECTIONS - AREA D
A5.11	SECTION DETAILS
A5.12	SECTION DETAILS
A5.13	SECTION DETAILS
A6.1	LARGE SCALE TOILET PLANS - FIRST FLOOR AREAS A & B
A6.2	LARGE SCALE TOILETS - FIRST FLOOR AREA B
A6.3	LARGE SCALE TOILETS - FIRST FLOOR AREA D
A6.4	LARGE SCALE PLANS & SECTION - STAIR 1
A6.5	LARGE SCALE PLANS & SECTION - STAIR 2
A6.6	LARGE SCALE PLANS & SECTION - STAIR 3

A6.7	LARGE SCALE PLANS, SECTIONS & DETAILS - STAIR 4 & PLATFORM
A6.8	LARGE SCALE ELEVATOR & DETAILS
A7.1	PLAN DETAILS
A7.2	PLAN DETAILS
A7.3	PLAN DETAILS
A7.4	PLAN DETAILS
A7.5	PLAN DETAILS
A8.1	DOOR ELEVATIONS AND DETAILS
A8.2	DOOR DETAILS
A8.3	WINDOW ELEVATIONS #1-12 AND SCHEDULE
A8.4	WINDOW ELEVATIONS #21-65
A8.5	WINDOW ELEVATIONS #66-100
A8.6	WINDOW DETAILS #1-20
A8.7	WINDOW DETAILS #21-40
A8.8	WINDOW DETAILS #41-60
A9.1	FIRST FLOOR REFLECTED CEILING PLAN AREA A
A9.2	FIRST FLOOR REFLECTED CEILING PLAN AREA B
A9.3	FIRST FLOOR REFLECTED CEILING PLAN AREA C
A9.4	FIRST FLOOR REFLECTED CEILING PLAN AREA D
A9.5	SECOND FLOOR REFLECTED CEILING PLAN AREA A
A9.6	SECOND FLOOR REFLECTED CEILING PLAN AREAS B & C
A10.1	INTERIOR ELEVATIONS
A10.2	INTERIOR ELEVATIONS
A10.3	INTERIOR ELEVATIONS
A10.4	INTERIOR ELEVATIONS
A10.5	INTERIOR ELEVATIONS
A10.6	INTERIOR ELEVATIONS
A10.7	INTERIOR ELEVATIONS
A10.8	INTERIOR ELEVATIONS
A10.9	INTERIOR ELEVATIONS
A10.10	INTERIOR ELEVATIONS
A10.11	INTERIOR ELEVATIONS
A10.12	INTERIOR ELEVATIONS
A11.1	INTERIOR CASEWORK ELEVATIONS
A11.2	INTERIOR & CASEWORK ELEVATIONS
A11.3	INTERIOR & CASEWORK ELEVATIONS
A11.4	INTERIOR & CASEWORK ELEVATIONS
A11.5	INTERIOR & CASEWORK ELEVATIONS
A11.6	INTERIOR & CASEWORK ELEVATIONS
A11.7	INTERIOR & CASEWORK ELEVATIONS
A11.8	INTERIOR & CASEWORK ELEVATIONS
A11.9	CASEWORK SECTIONS
A11.10	CASEWORK SECTIONS
A12.0	FINISH LEGEND AND NOTES
A12.1	FIRST FLOOR FINISH PLAN - AREA A
A12.2	FIRST FLOOR FINISH PLAN - AREA B
A12.3	FIRST FLOOR FINISH PLAN - AREA C
A12.4	FIRST FLOOR FINISH PLAN - AREA D
A12.5	SECOND FLOOR FINISH PLAN - AREA A
A12.6	SECOND FLOOR FINISH PLAN - AREAS B & C
A12.7	FINISH SCHEDULE - FIRST FLOOR
A12.8	FINISH SCHEDULE - SECOND FLOOR

A13.1	FIRST FLOOR FURNITURE PLAN AREA A
A13.2	FIRST FLOOR FURNITURE PLAN AREA B
A13.3	FIRST FLOOR FURNITURE PLAN AREA C
A13.4	FIRST FLOOR FURNITURE PLAN AREA D
A13.5	SECOND FLOOR FURNITURE PLAN AREA A
A13.6	SECOND FLOOR FURNITURE PLAN AREAS B & C

FOOD SERVICE

FS-G-1	GENERAL NOTES
FS-E-1	ELECTRICAL DETAILS
FS-P-1	PLUMBING DETAILS
FS-M-1	MECHANICAL DETAILS
FS-1.1.1	FOODSERVICE EQUIPMENT SCHEDULE
FS-1.2.1	FOODSERVICE EQUIPMENT PLAN AND SCHEDULE
FS-1.3.1	FOODSERVICE EQUIPMENT ELECTRICAL ROUGH-IN PLAN & SCHEDULE
FS-1.4.1	FOODSERVICE EQUIPMENT PLUMBING ROUGH-IN PLAN & SCHEDULE
FS-1.5.2	FOODSERVICE EQUIPMENT LIFE SAFETY PLAN
FS-1.6.1	FOODSERVICE EQUIPMENT ELEVATIONS REFERNCE PLAN
FS-1.6.2	FOOD SERVICE EQUIPMENT ELEVATIONS
FS-1.6.3	FOODSERVICE EQUIPMENT ELEVATIONS
FS-1.7.1	FOODSERVICE EQUIPMENT SPECIAL CONDITIONS PLAN
FS-1.7.2	FOODSERVICE EQUIPMENT SLAB PENETRATIONS PLAN
FS-1.7.3	FOODSERVICE EQUIPMENT EXHAUST CFM PLAN
FS-1.8.1	FOODSERVICE EQUIPMENT EXHAUST HOOD DETAILS
FS-1.8.2	FOODSERVICE EQUIPMENT EXHAUST HOOD DETAILS
FS-1.9.1	FOODSERVICE EQUIPMENT WALK IN DETAILS
FS-1.9.2	FOODSERVICE EQUIPMENT WALK IN DETAILS
FS-1.9.3	FOODSERVICE EQUIPMENT WALK IN DETAILS
FS-1.11.1	FOODSERVICE EQUIPMENT POWERSOAK DETAILS
FS-1.13.1	MULITERIA DETAILS
FS-1.13.2	MULITERIA DETAILS
FS-1.13.3	MULITERIA DETAILS

STRUCTURAL

S.0.0.1	STRUCTURAL GENERAL NOTES
S.0.0.2	STRUCTURAL TYPICAL DETAILS
S.0.0.3	STRUCTURAL TYPICAL DETAILS
S.0.0.4	STRUCTURAL TYPICAL DETAILS
S0.1	FOUNDATION PLAN - AREA 'A'
S0.2	FOUNDATION PLAN - AREA 'B'
S0.3	FOUNDATION PLAN - AREA 'C'
S0.4	FOUNDATION PLAN - AREA 'D'
S1.1	SECOND FLOOR FRAMING PLAN - AREA 'A'
S1.2	SECOND FLOOR FRAMING PLAN - AREA 'B' & PARTIAL 'C'
S2.1	ROOF FRAMING PLAN - AREA 'A'
S2.2	ROOF FRAMING PLAN - AREA 'B'
S2.3	ROOF FRAMING PLAN - AREA 'C'
S2.4	ROOF FRAMING PLAN - AREA 'D'
S3.1	COLUMN SCHEDULE AND PLAN DETAILS - AREA 'A'
S3.2	COLUMN SCHEDULE AND PLAN DETAILS - AREA 'B'
S3.3	COLUMN SCHEDULE AND PLAN DETAILS- AREA 'C'
S3.4	COLUMN SCHEDULE AND PLAN DETAILS- AREA 'D'

S3.5	VERTICAL BRACING DETAILS
S3.6	STRUCTURAL PLAN DETAILS - AREA 'A' AND 'B'
S3.7	STRUCTURAL PLAN DETAILS - AREA 'D'
S4.1	STRUCTURAL DETAILS
S4.2	STRUCTURAL DETAILS
S4.3	STRUCTURAL DETAILS
S4.4	STRUCTURAL DETAILS
S4.5	STRUCTURAL DETAILS
S4.6	STRUCTURAL DETAILS
S4.7	STRUCTURAL DETAILS
S4.8	STRUCTURAL DETAILS
S4.9	STRUCTURAL DETAILS
S4.10	STRUCTURAL DETAILS

VOLUME II OF II

SITE UTILITIES

SU-101	MEP SITE UTILITY PLAN
SU-102	MEP SITE UTILITY PLAN
SU-103	SITE LIGHTING ANALYSIS PLAN 3
SU-104	MEP SITE UTILITY PLAN

FIRE PROTECTION

FP0.00	FIRE PROTECTION LEGENDS AND SCHEDULES
FP1.1	FIRE PROTECTION FIRST FLOOR PLAN AREA A
FP1.2	FIRE PROTECTION FIRST FLOOR PLAN AREA B
FP1.3	FIRE PROTECTION FIRST FLOOR PLAN AREA C
FP1.4	FIRE PROTECTION FIRST FLOOR PLAN AREA D
FP1.5	FIRE PROTECTION SECOND FLOOR PLAN AREA A
FP1.6	FIRE PROTECTION SECOND FLOOR PLAN AREA B & C
FP4.0	FIRE PROTECTION DETAILS

PLUMBING

P0.00	PLUMBING NOTES AND LEGENDS
P1.1	PLUMBING FIRST FLOOR PLAN AREA A
P1.2	PLUMBING FIRST FLOOR PLAN AREA B
P1.3	PLUMBING FIRST FLOOR PLAN AREA C
P1.4	PLUMBING FIRST FLOOR PLAN AREA D
P1.5	PLUMBING SECOND FLOOR PLAN AREA A
P1.6	PLUMBING SECOND FLOOR PLAN AREA B & C
P1.7	PLUMBING ROOF AREA A
P1.8	PLUMBING ROOF AREA B
P1.9	PLUMBING ROOF AREA C
P1.10	PLUMBING ROOF AREA D
P2.1	PLUMBING KITCHEN PART PLAN
P2.2	PLUMBING KITCHEN PART PLAN
P5.00	PLUMBING DETAILS
P5.01	PLUMBING DETAILS
P6.00	PLUMBING SCHEDULES AND DIAGRAMS

MECHANICAL

M1.1	MECHANICAL DUCTWORK FIRST FLOOR PLAN - AREA A
M1.2	MECHANICAL DUCTWORK FIRST FLOOR PLAN - AREA B
M1.3	MECHANICAL DUCTWORK FIRST FLOOR PLAN - AREA C
M1.4	MECHANICAL DUCTWORK FIRST FLOOR PLAN - AREA D
M1.5	MECHANICAL DUCTWORK SECOND FLOOR PLAN - AREA A
M1.6	MECHANICAL DUCTWORK SECOND FLOOR PLAN - AREA B & C
MP1.1	MECHANICAL PIPING FIRST FLOOR - AREA A
MP1.2	MECHANICAL PIPING FIRST FLOOR - AREA B
MP1.3	MECHANICAL PIPING FIRST FLOOR- AREA C
MP1.4	MECHANICAL PIPING FIRST FLOOR - AREA D
MP1.5	MECHANICAL PIPING SECOND FLOOR - AREA A
MP1.6	MECHANICAL PIPING SECOND FLOOR - AREA B & C
M1.7	MECHANICAL ROOF AREA A
M1.8	MECHANICAL ROOF AREA B
M1.9	MECHANICAL ROOF AREA C
M1.10	MECHANICAL ROOF AREA D
M5.00	MECHANICAL DETAILS
M5.01	MECHANICAL DETAILS
M5.02	MECHANICAL DETAILS
M5.03	MECHANICAL DETAILS
M5.04	MECHANICAL DETAILS
M6.00	MECHANICAL SCHEDULES
M6.01	MECHANICAL SCHEDULES

ELECTRICAL

E0.0	ELECTRICAL ABBREVIATIONS, LEGEND
EL1.1	ELECTRICAL LIGHTING FIRST FLOOR - AREA A
EL1.2	ELECTRICAL LIGHTING FIRST FLOOR - AREA B
EL1.3	ELECTRICAL LIGHTING FIRST FLOOR - AREA C
EL1.4	ELECTRICAL LIGHTING FIRST FLOOR - AREA D
EL1.5	ELECTRICAL LIGHTING SECOND FLOOR - AREA A
EL1.6	ELECTRICAL LIGHTING SECOND FLOOR - AREA B
EL1.7	ELECTRICAL LIGHTING SECOND FLOOR - AREA C
EP1.1	ELECTRICAL POWER FIRST FLOOR - AREA A
EP1.2	ELECTRICAL POWER FIRST FLOOR - AREA B
EP1.3	ELECTRICAL POWER FIRST FLOOR - AREA C
EP1.4	ELECTRICAL POWER FIRST FLOOR - AREA D
EP1.5	ELECTRICAL POWER SECOND FLOOR - AREA A
EP1.6	ELECTRICAL POWER SECOND FLOOR - AREA B
EP1.7	ELECTRICAL POWER SECOND FLOOR - AREA C
EP1.8	ELECTRICAL POWER ROOF AREA A
EP1.9	ELECTRICAL POWER ROOF AREA B
EP1.10	ELECTRICAL POWER ROOF AREA C
EP1.11	ELECTRICAL POWER ROOF AREA D
EF1.1	ELECTRICAL FIRE ALARM FIRST FLOOR - AREA A
EF1.2	ELECTRICAL FIRE ALARM FIRST FLOOR - AREA B
EF1.3	ELECTRICAL FIRE ALARM FIRST FLOOR - AREA C
EF1.4	ELECTRICAL FIRE ALARM FIRST FLOOR - AREA D
EF1.5	ELECTRICAL FIRE ALARM SECOND FLOOR - AREA A
EF1.6	ELECTRICAL FIRE ALARM SECOND FLOOR - AREA B
EF1.7	ELECTRICAL FIRE ALARM SECOND FLOOR - AREA C

E3.00	ENLARGED KITCHEN PLAN
E3.01	ENLARGED SERVER/IDF ROOM FLOOR PLANS
E4.00	ELECTRICAL DETAILS-1
E4.01	ELECTRICAL DETAILS-2
E4.02	ELECTRICAL DETAILS-3
E4.03	ELECTRICAL DETAILS-4
E4.04	ELECTRICAL DETAILS-5
E4.05	ELECTRICAL DETAILS-6
E4.06	ELECTRICAL DETAILS-7
E4.07	ELECTRICAL DETAILS-8
E4.08	ELECTRICAL DETAILS-9
E4.09	ELECTRICAL DETAILS-10
E5.00	LIGHT FIXTURE/MOTOR CIRCUIT SCHEDULES
E6.00	ELECTRICAL POWER RISERS
E6.02	PV RISER DIAGRAM
E7.00	ELECTRICAL PANEL SCHEDULES
E7.01	ELECTRICAL PANEL SCHEDULES
E7.02	ELECTRICAL PANEL SCHEDULES
E7.03	ELECTRICAL PANEL SCHEDULES

TECHNOLOGY

T1.0	TECHNOLOGY LEGEND AND NOTES
T1.1	FIRST FLOOR TECHNOLOGY - AREA A
T1.2	FIRST FLOOR TECHNOLOGY - AREA B
T1.3	FIRST FLOOR TECHNOLOGY - AREA C
T1.4	FIRST FLOOR TECHNOLOGY - AREA D
T1.5	SECOND FLOOR TECHNOLOGY - AREA A
T1.6	SECOND FLOOR TECHNOLOGY - AREA B & C
T1.7	SITE PLAN - CAMERA LOCATIONS
T2.1	LARGE SCALE PLANS
T2.2	TECHNOLOGY DETAILS
T2.3	TECHNOLOGY DETAILSOLUME II OF II

END OF SECTION 000115

SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes pipe, fittings, valves, backflow preventers and connections for sprinkler and standpipe systems.

B. Related Sections:
1. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for inserts and sleeves specified by this section.
2. Section 09 90 00 - Painting and Coating: Execution requirements for piping painting specified by this section.
3. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Piping.
4. Section 21 05 48 – Vibration and Seismic Controls for Fire-Suppression Piping and Equipment.
5. Section 21 12 00 – Fire Suppression Standpipes.
6. Section 21 13 13 – Wet-Pipe Sprinkler System.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
2. ASME B16.3 – Malleable Iron Threaded Fittings, Class 150 and 300.
3. ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
4. ASME B16.5 - Pipe Flanges and Flanged Fittings
5. ASME B16.9 – Factory-made Wrought Steel Butt Welding Fittings.
6. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
7. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
8. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
9. ASME B16.25 – Butt Welding Ends.
10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
11. ASME Sec 9 - Welding and Brazing Qualifications.

B. American Society of Sanitary Engineers:
1. ASSE 1013 – Standard for Reduced Pressure Principal Backflow Preventer
2. ASSE 1015 – Standard for Double Check Backflow Preventer Assembly
3. ASSE 1047 – Standard for Reduced Pressure Detector Backflow Preventer
4. ASSE 1048 – Standard for Double Check Detector Assembly Backflow Preventer.

C. ASTM International:
1. ASTM A47 – Malleable Iron Castings.
2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
4. ASTM A126 – Standard for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
5. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
6. ASTM A536 – Standard for Ductile Iron Casting.

7. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
8. ASTM B32 - Standard Specification for Solder Metal.
9. ASTM B75 - Standard Specification for Seamless Copper Tube.
10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
11. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.

D. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.
3. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.

E. American Water Works Association:
1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
4. AWWA C510 – Standard for Double Check Valve Backflow Prevention Assembly.
5. AWWA C511 – Standard for Reduced Pressure Principal Backflow Prevention Assembly.
6. AWWA C606 – Standard for Grooved and Shouldered Joints.

F. National Fire Protection Association:
1. NFPA 13 - Installation of Sprinkler Systems.
2. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
3. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.

G. Underwriter Laboratories, Inc.:
1. UL 1887 - Fire Tests of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.
2. UL - Fire Resistance Directory.

H. Factory Mutual:
1. FM - Factory Mutual Approval Guide.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

C. Shop Drawings: shop drawings for fire the sprinkler system shall be submitted to indicate conformance to Connecticut State Building Code and construction documents and shall be approved prior to the start of system installation.

D. Product Data: Submit manufacturer’s catalogue information. Provide data on valves, and fittings, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

E. Grooved joint couplings and fittings shall be shown on shop drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series designation.

F. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and all code requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of components and tag numbering.

C. Operation and Maintenance Data: Submit spare parts lists.

1.5 QUALITY ASSURANCE

A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install sprinkler systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).

B. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities, including those of the State of Connecticut, State Fire Marshall, local ordinances and OSHA. Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.

C. In addition to complying with the above codes and regulations, comply with the requirements of the following:
1. NFPA Standard 13.
2. NFPA Standard 14.
3. NFPA Standard 24.
4. State Building and Fire Codes.
5. Local Jurisdictional Authorities.

D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

E. Valves: Bear UL and/or FM label or marking. Provide manufacturer’s name and pressure rating marked on valve body.

F. All items of similar class shall be the products of the same manufacturer. All valves, accessory items, etc., shall be from the same source.

G. Provide fire sprinkler piping located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with UL 1887.

H. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Deliver and store valves in shipping containers, with labeling in place.

C. Furnish cast iron and steel valves with temporary protective coating.

D. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. All equipment, valves, gages and etc., shall be covered and protected during the execution of the work. All equipment and piping shall be protected from freezing. Labeling to remain in place.

F. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.

G. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for basic fire suppression materials and methods.

1.10 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two sets of valve stem packing for each size and type of valve installed.

PART 2 PRODUCTS

2.1 VALVES

A. Manufacturers:
1. Kennedy Valve Mfg. Co.
2. Victaulic.
3. Stockham.
4. Nibco.
5. Watts.
6. Hammond.
7. Milwaukee.
8. Substitutions: Section 01 60 00 - Product Requirements.

B. Gate Valves:
1. Up to and including 2 inches: Bronze body and trim, 175 lb, cold water non-shock working pressure, rising stem, hand wheel, solid wedge or disc, threaded ends.
2. Over 2 inches: Iron body, bronze trim, 175 lb, cold water non-shock working pressure, rising stem pre-grooved for mounting tamper switch, hand wheel, outside screw and yoke, solid taper bronze or cast iron wedge, grooved or flanged ends.
3. Over 4 inches: Iron body, bronze trim, 175 pound cold water, non-shock working pressure. Valve shall have solid taper wedge; outside screw and yoke, rising stem; flanged bonnet with body and bonnet conforming to ASTM A126 Class B; replaceable bronze wedge facing rings; grooved or flanged ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet and bronze bonnet bushing. Valve shall be capable of being repacked under pressure, with valve wide open.

C. Globe Valves:
1. Up to and including 2 inches: Class 125, Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity, packable under pressure.
2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

D. Ball Valves:
1. Up to and including 2 inches: Bronze two piece body, standard port, chrome plated brass ball, 316 stainless steel stem, teflon seats brass stem nut, die-cast brass gear box with supervisory switches, threaded or grooved ends.
2. Over 2 inches: Manufacturers: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle.

E. Butterfly Valves:
1. Ductile iron body, ductile iron disc with EPDM disc coating and integrally cast stem, grooved ends.
2. Cast bronze body, ductile iron disc with EPDM disc coating and integrally cast stem, copper-tubing dimensioned grooved ends.
3. Cast iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck with 316 stainless steel stem, MSS-SP-67, 200 psi.
4. Disc: EPDM coated ductile iron or Aluminum bronze.

5. Operator: Notched plate lever handle. handwheel and weatherproof actuator with supervisory switches.

F. Check Valves:
1. Up to and including 2 inches: Class 125, Bronze swing disc, screwed ends.
2. Horizontal Swing Over 2 inches:
a. 300 psi CWP, ductile iron body and coupled cap conforming to ASTM A536, Grade 65-45-12; horizontal swing, with stainless steel disc, elastomer seat, and grooved ends.
b. Class 175, cast iron body and bolted cap conforming to ASTM A126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends.
c. Valve shall be capable of being refitted while the valve remains in line.
3. Spring Actuated Over 2 inches:
a. 300 psi CWP, ductile iron body conforming to ASTM A536, Grade 65-45-12; vertical or horizontal check; with stainless steel spring and shaft.
1) 2-1/2 (65 mm) and 3 inches (75 mm): Aluminum bronze disc with disc mounted elastomer seal and PPS (Polyphenylene Sulfide) coated seat.
2) 4 inches (100 mm) and Larger: Elastomer coated ductile iron disc with welded-in nickel seat.

G. Drain Valves:
1. Compression Stop: Bronze with hose thread nipple and cap.
2. Ball Valve: Brass with cap and chain, 3/4 inch hose thread.

H. All valves shall be either UL listed or FM approved for use on fire protection systems.

2.2 BACKFLOW PREVENTERS

A. Double Check Detector Check Valve Assemblies: ANSI/ASSE 1048, AWWA C510; bronze body; two independently operating, spring loaded check valves; metered bypass; assembled with two gate valves, strainer, test cocks. Watts 709RPDA or approved equal.

2.3 BURIED PIPING

A. Ductile Iron Pipe: ANSI/AWWA C151, cement lined.
1. Fittings: ANSI/AWWA C110, standard thickness.
2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings.
3. Joints: ANSI/AWWA C111, rubber gasket.

2.4 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A53; Schedule 40 seamless carbon steel. Schedule 10 pipe shall be allowed for pipe sizes larger than 2” diameter when roll grooved mechanical couplings are used. Plain end joint connections shall not be used.
1. Cast Iron Fittings: ANSI/ASME B16.1, flanges and flanged fittings; ANSI/ASME B16.4, screwed fittings.
2. Malleable Iron Fittings: ANSI/ASME B16.3, screwed Class 300 type. Threads shall conform to ANSI/ASTM A47.
3. Grooved Mechanical Fittings: ANSI A21.10/AWWA C-110 ductile iron; ASTM A536 Grade 65-45-12 ductile iron; ASTM A234 Grade WPB; or factory fabricated from carbon steel pipe conforming to ASTM A53; with grooves or shoulders designed to accept grooved

end couplings. Fittings shall be of the same manufacturer as the adjoining couplings. Grooved Mechanical Couplings: ASTM A536 Grade 65-45-12, ductile iron housing, elastomer gasket with nuts and bolts to secure roll grooved pipe and fittings.

Fire Protection Service	Temperature Range	Gasket Recommendation
Dry Systems	Ambient	FlushSeal®, or EZ Style 009 design Grade EPDM, Type A
Freezer Applications	-40°F to 0°F	FlushSeal®, Grade L, Silicone
Water/Wet Systems	Ambient	C-Shape or EZ Style 009

a. Rigid Type Couplings: Housings cast with offsetting, angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with NFPA-13.
   1) 1-1/4” through 4”: Factory assembled for direct stab installation without field disassembly. Victaulic Style 009 EZ.
   2) 5” through 8”: Victaulic FireLock™ Style 005.
   3) 10” and larger: Victaulic Zero-Flex® Style 07.

b. Flexible Type Couplings: Use in locations where vibration attenuation and stress relief are required, and for seismic considerations in accordance with the manufacturer’s instructions. Victaulic Style 75.

B. Cast Iron Pipe: AWWA C151.
   1. Fittings: AWWA C110, standard thickness.
   2. Joints: AWWA C111, rubber gasket.
   3. Mechanical Grooved Couplings: Ductile iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.5 UNIONS AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches (50 mm) and Under:
   1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
   2. Copper Pipe: Bronze, soldered joints.

B. Dielectric Connections: Union, waterway fitting, or flange with water impervious isolation barrier; Victaulic Style 47 or Watts 3000 Series or approved equal.

2.6 PIPE HANGERS AND SUPPORTS

A. Conform to NFPA 13, NFPA 14.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, Carbon steel, adjustable swivel, split ring.

C. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.

D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

E. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.

F. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.

G. Vertical Support: Steel riser clamp

H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

I. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate work of this Section with other affected work.

B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

C. Remove scale and foreign material, from inside and outside, before assembly.

D. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION – GENERAL

A. Install in accordance with manufacturer’s instructions.

B. The Contractor shall provide a complete and fully code compliant fire suppression system throughout the entire building.

C. The Contractor shall maintain a clean and orderly site during the installation of the sprinkler system. Materials shall not be stored in the halls or other public areas.

D. Cutting, welding and other hot work shall not be permitted without permission from the building owner. Contractor shall provide a fire watch for one hour after all welding.

E. The required tests shall be witnessed by the Fire Marshall, authority having jurisdiction, Owner's insurance underwriter and Architect/Engineer.

F. Pipe Hangers and Supports:
1. Install in accordance with NFPA 13 and NFPA 14.
2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
3. Place hangers within 12 inches of each horizontal elbow.
4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.3 INSTALLATION – PIPE AND FITTINGS

A. Pipe/insulation: All wet sprinkler piping must be plumbed on the heated side of the building insulation to prevent freezing. The fire protection contractor must install the wet sprinkler piping such that space is provided around all wet piping for insulation to be installed. The space required for insulation is dictated by the insulation R-value for the specific area as specified by the Architect.

B. Install piping in accordance with NFPA 13 for sprinkler systems, NFPA 14 for standpipe and hose systems, and NFPA 24 for service mains.

C. Place piping in concealed spaces above finished ceilings unless noted otherwise.

D. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

E. Install piping to conserve building space, to not interfere with use of space and other work.

F. Group piping whenever practical at common elevations.

G. Install pipe sleeve at piping penetrations through footings partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Use Victaulic Style 77 or 75 couplings in accordance with Victaulic instructions for expansion and contraction of pipe.

I. Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.

J. Pitch piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Section 09 90 00.

L. Do not penetrate building structural members unless indicated.

M. Provide sleeves when penetrating footings, floors and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.

N. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.

O. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

P. Provide dielectric fittings whenever joining two dissimilar metals.

Q. Provide surge restrainers on all end of branches and arm overs in excess of 12-inches.

3.4 INSTALLATION – VALVES

A. Install drain valves at main shut-off valves, low points of piping and apparatus.

B. All valves shall be accessible for operation and servicing. Provide access panels where required.

C. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to after installation.

D. Install gate or butterfly valves for shut-off or isolating service.

E. Install buried shut-off valves in valve box.

F. Provide Double check valve assembly with detector check assembly at sprinkler system water source connection. Install a drain line from the air gap fitting and terminate at the nearest floor drain. The backflow preventer shall be installed at a minimum height to allow installation of the air gap fitting, but shall not be installed at more than 5’0” above finished floor for maintenance.

3.5 SERVICE CONNECTION

A. Provide new fire service complete with reduced pressure double detector check valve assembly and isolation valves with tamper switches.
   1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.
   2. Provide 18 gage (1.20 mm) galvanized sheet metal sleeve around service main to 6 inch (150 mm) above floor and 6 feet (1800 mm) minimum below grade. Size for minimum of 2 inches (50 mm) of loose batt insulation stuffing. Provide Link Seal Modular Seal assembly Model C for temperature rating of -40°F to 250°F. Install per manufacturers written instructions.

3.6 TESTING

A. Piping: The complete system shall be subject to a pressure test, acceptance testing per the Connecticut State Fire Safety Code, and to such other tests as the authorities having jurisdiction may require. The pressure test shall be a hydrostatic pressure of 200 pounds per square inch for a period of two hours. The above ground piping and attached appurtenances shall show no pressure loss or leaks, refer to NFPA Standard 13 Hydrostatic tests. For buried piping refer to NFPA Standard 24 Testing Underground Systems. Before applying specified test pressure, all air must be expelled from the system. All defects of whatever type shall be repaired or replaced to the satisfaction of the Owner and authorities having jurisdiction and at no additional cost to the Owner. Packing rings, special joint bolts, gaskets, and other material required for the proper installation of the pipe and fittings shall be provided. Testing shall be completed prior to permanent sealing of walls and partitions.

B. Leaks in mechanical joints shall be repaired by dismantling the joint, reassembling it, and tightening the bolts in the correct order. Leaks in screw or grooved joint shall be repaired by dismantling the joint and reassembling it. Attempting to repair leaks in joints by over tightening the bolts or fittings shall not be permitted.

C. Upon satisfactory completion of all tests, the Contractor shall submit three copies of the Standard Contractors Material and Test Certificate to the Owner.

3.7 INTERFACE WITH OTHER PRODUCTS

A. Inserts:
1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Install hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.8 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean entire system after other construction is complete.

END OF SECTION

SECTION 210516 - EXPANSION FITTINGS AND LOOPS FOR FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

A. Section Includes:
1. Flexible pipe connectors.
2. Expansion joints.
3. Expansion compensators.
4. Pipe alignment guides.
5. Swivel joints.
6. Pipe anchors.

B. Related Sections:
1. 21 05 00 - Common Work Results for Fire Suppression: Product and installation requirements for piping used in fire protection systems.
2. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
3. Section 21 12 00 - Fire-Suppression Standpipes.
4. Section 21 13 13 – Wet-Pipe Sprinkler System.

1.3 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.9 - Building Services Piping.
2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

1.4 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Expansion Compensation Design Criteria:
1. Installation Temperature: 50 degrees F.
2. Fire Protection System Temperature: 50 degrees F.
3. Safety Factor: 30 percent.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered professional engineer.

C. Product Data:
1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

D. Design Data: Indicate criteria and show calculations. Submit sizing methods and calculations sealed by a registered professional engineer.

E. Manufacturer's Installation Instructions: Submit special procedures.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX. AWS D1.1.

H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

C. Operation and Maintenance Data: Submit adjustment instructions.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with the Connecticut State Building Code and Connecticut State Fire Safety Code.

C. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Connecticut

1.9 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for leak free performance of packed expansion joints.

1.12 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Supply two 12 ounce containers of packing lubricant and cartridge style grease gun.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:
1. Mason.
2. Metraflex.
3. Vibration Eliminator.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Steel Piping:
1. Inner Hose: Stainless Steel.
2. Exterior Sleeve: Double braided stainless steel
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint: Flanged or Threaded with Union
5. Size: Use pipe-sized units.

6. Maximum offset: 1 inch on each side of installed center line.

2.2 EXPANSION JOINTS

A. Manufacturers:
1. Metraflex.
2. Mason.
3. Vibration Elimination.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Stainless Steel Bellows Type:
1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Maximum Compression: 1-3/4 inch 3 inch.
3. Maximum Extension: 1/4 inch.
4. Joint: Flanged Threaded
5. Size: Use pipe sized units
6. Application: Steel piping 3 inch and smaller.

C. External Ring Controlled Stainless Steel Bellows Type:
1. Pressure Rating: 200 psig WOG and 250 degrees F
2. Maximum Compression: 15/16 inch 1-1/4 inch.
3. Maximum Extension: 5/16 inch 3/8 inch.
4. Maximum Offset: 1/8 inch 5/16 inch.
5. Joint: Flanged
6. Size: Use pipe sized units
7. Accessories: Internal flow liner.
8. Application: Steel piping 3 inch and larger.

D. Single Double Sphere, Elbow Flexible Compensators:
1. Body: Teflon Neoprene and nylon
2. Working Pressure: 120 psi
3. Maximum Temperature: 140 degrees F.
4. Maximum Compression: 1 inch.
5. Maximum Elongation: 7/8 inch.
6. Maximum Offset: 3/4 inch 7/8 inch.
7. Maximum Angular Movement: 30 degrees.
8. Joint: Tapped steel flanges, Galvanized flanges, Galvanized unions.
9. Size: Use pipe sized units
10. Accessories: Control cables.
11. Application: Steel piping 2 inch and larger.

E. Two-ply Bronze Bellows Type:
1. Construction: Bronze with anti-torque device, limit stops, internal guides.
2. Pressure Rating: 200 psi WOG and 250 degrees F.
3. Maximum Compression: 1-3/4 inch.
4. Maximum Extension: 1/4 inch.
5. Joint: Soldered
6. Size: Use pipe sized units
7. Application: Copper piping.

F. Low Pressure Compensators with two-ply Bronze Bellows:
1. Working Pressure: 80 psig.
2. Maximum Temperatures: 250 degrees F.
3. Maximum Compression: 1/2 inch.
4. Maximum Extension: 5/32 inch.
5. Joint: Soldered.
6. Size: Use pipe sized units
7. Application: Copper or steel piping 2 inch and smaller.

2.3 ACCESSORIES

A. Manufacturers:
1. Metraflex.
2. Mason.
3. Vibration Elimination.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

C. Swivel Joints: Fabricated steel Cast steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install Work in accordance with ASME B31.9

B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Refer to Section 21 05 48. Provide line size flexible connectors.

C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.

E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required. Refer to Section 21 05 00 for pipe hanger installation requirements. Refer to architectural and structural drawings for location of expansion joints.

F. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.

G. Provide expansion loops as required indicated on Drawings.

3.2 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers’ field services.

B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

SECTION 210548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE PROTECTION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 INTENT

A. All fire protection equipment and piping as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.

B. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.

C. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.

D. All such systems must be installed in strict accordance with seismic codes, component manufacturer's recommendations and building construction standards. Whenever a conflict occurs between the manufacturer's recommendations or construction standards, the most stringent shall apply.

E. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements).

F. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.2 SUMMARY

A. Section Includes:
1. Certification of seismic restraint designs and installation supervision.
2. Certification of seismic attachment of housekeeping pads.
3. NOTE: For all mechanical and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included.
4. Seismic restraint products
    a. Vibration isolation elements.
    b. Equipment isolation bases.
    c. Piping flexible connections.
    d. Seismic restraints for isolated and non-isolated mechanical and electrical items.
5. Inertia bases.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of isolators in floating floor slabs specified by this section and product requirements for concrete for placement by this section.
2. Section 07 90 00 - Joint Protection: Product requirements for joint sealers specified for placement by this section.

3. Section 21 04 00 – General Conditions for Fire protection Trades
4. Section 21 05 16 - Expansion Fittings and Loops for Fire protection Piping: Product requirements for anchors and piping expansion compensation.
5. Section 21 05 29 - Hangers and Supports for Fire protection Piping and Equipment: Product requirements for pipe hangers and supports.

1.3 REFERENCES

A. American National Standards Institute:
1. ANSI S1.4 - Sound Level Meters.
2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
3. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

B. Air-Conditioning and Refrigeration Institute:
1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.

C. American Society of Heating, Refrigerating and:
1. ASHRAE Handbook - HVAC Applications.

1.4 RELATED WORK

A. Housekeeping Pads
1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel
1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.

C. Attachments
1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.5 SEISMIC FORCE LEVELS

A. Installations shall be designed to safely accept external forces determined in accordance with the International Building Code –2003, Section 1621 in any direction for all rigidly supported equipment without failure and permanent displacement of the equipment. Seismic restraints shall not short circuit vibration isolation systems or transmit objectionable vibration or noise.

1.6 DEFINITIONS

A. Life Safety Systems:
1. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flow paths to fire protection and/or emergency lighting systems.

B. Positive Attachment:
1. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, fire protection, electrical conduit, or any other equipment are not acceptable on this project as seismic anchor points.

C. Transverse Bracing:
1. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe or conduit.

D. Longitudinal Bracing:
1. Restraint(s) applied to limit motion parallel to the centerline of the pipe or conduit.

E. Failure
1. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" (3mm) and/or horizontal permanent deformation greater that 1/4" (6mm).

1.7 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings:
1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
2. Provide Drawings showing methods of suspension and support guides for conduit, piping and ceiling hung equipment.
3. Record actual locations and installation of vibration isolators and seismic restraints including attachment points.
4. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
5. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
6. Drawings showing methods for isolation of conduits and pipes penetrating walls and floor slabs.
7. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, for each piece of equipment and/or pipe locations.

C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

D. Seismic Certification and Analysis:
1. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
2. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45 degrees to the weakest mode.
3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in section 1.06 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

E. Design Data: Submit calculations indicating maximum room sound levels are not exceeded. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as express in Table 34 of Chapter 47, “Sound and Vibration Control” of the 2003 ASHRAE Handbook – HVAC Applications, shall be used.

F. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers. acoustic housings meet or exceed specified sound transmission loss values.

G. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.

H. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

I. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.8 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of hangers including attachment points.

1.9 QUALITY ASSURANCE

A. Perform Work in accordance with ARI 575 ANSI S12.36.

B. Maintain one copy of each document on site.

1.10 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design application of seismic bracing under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.11 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.12 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.13 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall have the following responsibilities:
   1. Determine vibration isolation and seismic restraint sizes and locations per specifications.
   2. Provide and install isolation systems and seismic restraints as scheduled or specified.
   3. Guarantee specified isolation system deflection.
   4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
   5. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
   6. Substitution of "Internally Isolated" mechanical equipment in lieu of the specified isolation of this section is acceptable

1.14 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for inertia bases.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers:
   1. Mason
   2. Vibration Eliminator
   3. Amber Booth
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Open Spring Isolators:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
   4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

C. Restrained Spring Isolators:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
   4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
   5. Restraint: Furnish mounting frame and limit stops.

D. Closed Spring Isolators:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
   3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.

E. Restrained Closed Spring Isolators:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
   3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.

F. Spring Hanger:
1. Spring Isolators:
a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators rubber hanger with threaded insert.
4. Misalignment: Capable of 20 degree hanger rod misalignment.

G. Neoprene Pad Isolators:
1. Rubber or neoprene-waffle pads.
a. 30 durometer.
b. Minimum 1/2 inch thick.
c. Maximum loading 40 psi.
d. Height of ribs: not to exceed 0.7 times width.
2. Configuration: Single layer.

H. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

I. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

J. Seismic Snubbers:
1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Neoprene Elements: Replaceable, minimum of 0.75 inch thick.
3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify equipment and piping is installed before work in this section is started.

3.2 INSTALLATION

A. Bases:
1. Set steel bases for 1 inch clearance between housekeeping pad and base.
2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.

B. Adjust equipment level.

C. Install spring hangers without binding.

D. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

E. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

F. Provide resiliently mounted equipment and piping with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.

G. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector. as follows:
1. Up to 4 inch Diameter: First three points of support.
2. 5 to 8 inch Diameter: First four points of support.
3. 10 inch Diameter and Over:First six points of support.
4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect isolated equipment after installation and submit report. Include static deflections.

C. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to plumbing equipment rooms, and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

D. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

3.4 SCHEDULES

A. Pipe Isolation Schedule:

Pipe Size Inch	Isolated Distance from Equipment
1	120 diameters
2	90 diameters
3	80 diameters
4	75 diameters
6	60 diameters
8	60 diameters
10	54 diameters

12	50 diameters
16	45 diameters
24	38 diameters
Over 24	

3.5 VIBRATION ISOLATION AND SEISMIC RESTRAINT INSTALLATION

A. Horizontal pipe isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in specification 11. Specification 11 hangers must also be used in all transverse braced isolated locations. Brace hanger rods with SRC clamps specification 14. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in specification 10. Floor supported piping shall rest on isolators as described in specification 6. Heat exchanger's and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical. Where piping connects to mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.

B. Riser isolation: Risers shall be suspended from specification 10 hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to $\pm$ 25% of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

C. Seismic Restraint of Piping
   1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables if isolated. Specification 12 or 13 restraints may be used on unisolated piping.
      a. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" (32mm) I.D. and larger.
      b. All other piping 2 1/2" (64mm) diameter and larger.
   2. Transverse piping restraints shall be at 40' (12m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
   3. Longitudinal restraints shall be at 80' (24m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
   4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
   5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" (600m) of the elbow or TEE or combined stresses are within allowable limits at longer distances.
   6. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.

7. Branch lines may not be used to restrain main lines.
8. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly in Zones 2B, 3 and 4 shall be braced as in sections 3.2.D.2 and 3. For Zones 0, 1 and 2A, 2 band clamps may be used with reduced spacings of 1/2 of those listed in sections 3.2.D.2 and 3.

D. Vibration Isolation and Seismic Restraint of Fire Suppression Equipment
1. All equipment shall be vibration isolated and seismically restrained as per the schedules in part 3.5 of this specification.
2. Equipment mounted on housekeeping pads: Pads shall be properly doweled or expansion shielded to deck to meet acceleration criteria.
3. Requirements for installation on concrete inertia bases shall be as follows:
   a. Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".
   b. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
   c. The isolators shall be installed without raising the machine and frame assembly.
   d. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
   e. Install equipment with flexibility in wiring connection.
   f. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".
   g. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators, or seismic restraints.

3.6 SEISMIC RESTRAINT EXCLUSIONS

A. General: All fire suppression, mechanical and electrical components and systems that are considered exempt from the requirement for seismic restraint, in accordance with The International Building Code – 2003, Section.1621 and all related State of Connecticut Supplements, shall not require seismic restraint.

B. Piping
1. Piping in boiler and mechanical rooms less than 1 1/4" (32mm) inside diameter.
2. All other piping less than 2 1/2" (64mm) inside diameter.
3. All piping suspended by individual hangers 12" (300mm) or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" (300mm) limit is exceeded by any hanger in the run, seismic bracing is required for the run.
4. The 12" (300mm) exemption applies for trapeze supported systems if the top of each item supported by the trapeze qualifies.

3.7 INSPECTION

A. Examine systems under provisions of Division 1.

B. On completion of installation of all vibration isolation devices herein specified, the local representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 21 08 00 - COMMISSIONING OF FIRE SUPPRESSION

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 includes commissioning process requirements for Fire Suppression systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

A. Refer to Division 01 Section “General Commissioning Requirements” for the description of commissioning.

1.4 DEFINITIONS

A. Refer to Division 01 Section “General Commissioning Requirements” for definitions.

1.5 SUBMITTALS

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s role.

B. Refer to Division 01 Section “Submittals” for specific requirements. In addition, provide the following:

C. Certificates of readiness

D. Certificates of completion of installation, prestart, and startup activities.

E. O&M manuals

F. Test reports

1.6 QUALITY ASSURANCE

A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the contractor for the equipment being tested. For example, the fire protection contractor of Division 21 shall ultimately be responsible for all standard testing equipment for the plumbing system in Division 21.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for applicable commissioned components, equipment, and systems.

B. Red-lined Drawings: The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.

C. Operation and Maintenance Data: Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been mad by the contractor.

D. Demonstration and Training: Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior the training session

3.2 CONTRACTOR'S RESPONSIBILITIES

A. Perform tests that are specified in the Division 21.

B. Attend construction phase coordination meetings.

C. Participate in Fire Suppression systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

D. Provide information requested by the CxA for final commissioning documentation.

E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.

F. Prepare preliminary schedule for Fire Suppression system orientations and inspections, operation and maintenance manual submissions, training sessions, flushing and cleaning, equipment start-up, and task completion for owner. Distribute preliminary schedule to commissioning team members.

G. Update schedule as required throughout the construction period.

H. Assist the CxA in all verification and functional performance tests.

I. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

J. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.

K. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.

L. Participate in, and schedule vendors and contractors to participate in the training sessions.

M. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
   1. Life Safety/Fire Suppression equipment including pumps, piping, and all other equipment furnished under this Division.
   2. Automatic sprinkler and standpipe systems.
   3. Fire stopping in fire rated construction, including caulking, gasketing and sealing of smoke barriers.

N. The equipment supplier shall document the performance of his equipment.

O. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.

P. Equipment Suppliers
   1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
   2. Assist in equipment testing per agreements with contractors.
   3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.

Q. Refer to Division 01 Section “General Commissioning Requirements” for additional contractor responsibilities.

3.3 CxA'S RESPONSIBILITIES

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s Responsibilities.

3.4 TESTING PREPARATION

A. Certify in writing to the CxA that Life Safety/Fire Suppression systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify in writing to the CxA that Life Safety/Fire Suppression instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the position of each device and interlock identified on checklists.

E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.5 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of Life Safety/Fire Protection testing shall include entire Fire Suppression installation. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions.

D. The CxA along with the Fire Suppression contractor may prepare detailed testing plans, procedures, and checklists for Fire Suppression systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the Fire Suppression system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.6 FIRE SUPPRESSION SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 21 sections. Provide submittals, test data, inspector record, and certifications to the CxA.

B. Fire Suppression Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of sprinkler distribution systems.

C. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

Fire Suppression Systems

3.7 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.8 APPROVAL

A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.9 DEFERRED TESTING

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.10 OPERATION AND MAINTENANCE MANUALS

A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.

B. Refer to Division 01 Section “General Commissioning Requirements” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.11 TRAINING OF OWNER PERSONNEL

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to training.

END OF SECTION 21 08 00

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes wet-pipe sprinkler system, system design, installation, and certification.

B. Related Sections:
1. Section 21 05 00 - Common Work Results for Fire Suppression: Product and execution requirements for pipe, fittings, valves, hangers, supports, identification and painting for placement by this section.
2. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Equipment.
3. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.2 REFERENCES

A. National Fire Protection Association:
1. NFPA 13 - Installation of Sprinkler Systems.
2. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.

B. Factory Mutual:
1. FM - Factory Mutual Approval Guide.

C. Underwritters Laboratory:
1. UL - Fire Resistance Directory.

1.3 SYSTEM DESCRIPTION

A. Provide a wet pipe system hydraulically designed in accordance with NFPA 13 and all requirements of the local Authority Having Jurisdiction.

B. System to provide coverage for entire building.

C. Provide system to NFPA Standard occupancy requirements as noted on the drawings.

D. Hydraulic data and water supply information shall be as noted on the drawings.

E. Interface system with building fire alarm system.

F. The sprinkler locations and piping arrangements indicated on the contract documents are diagrammatic. It is the responsibility of the contractor to fully coordinate sprinkler and piping locations with all other trades.

G. Sprinkler locations indicated on the Contract Documents indicate sprinkler coverage utilizing standard coverage sprinklers maximum 225 square feet per sprinkler for light hazard and 130

square feet per sprinkler for ordinary hazard. Extended coverage sprinklers shall not be installed in any locations unless specifically indicated on the Contract Document drawings.

H. All sprinklers installed in a light hazard classification occupancy shall be a listed quick response type.

I. Provide fire department connections as indicated on Drawings.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Where the terms “authorities having jurisdiction” is used, within this Specification, it is intended to include the Insurance Underwriter and all regulatory agencies having vested interest in this project.

C. Shop Drawings:
1. Provide fire protections shop drawings drawn to a minimum scale of ¼”=1’-0”. Indicate pipe materials used, joining methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
2. Provide hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories. Indicate system controls.
3. All sprinkler drawings and calculations shall bear the seal of a Professional Engineer licensed in the State of Connecticut. Seal and signature shall not be copied and shall be provided as an original drawing and each calculation.
4. Sprinklers shall be as shown on drawings and submittals and shall be specifically identified with the applicable style or series designation as published in the appropriate agency listing or approval. Trade names or other abbreviated designations are not permitted.

D. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

E. After successful review by the Engineer, submit sprinkler layout shop drawings, product data, hydraulic calculations to authority having jurisdiction, Fire Marshall, and Owner's insurance underwriter for approval. Submit proof of approval to Architect/Engineer.

F. Grooved joint couplings and fittings shall be shown on shop drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series designation.

G. Manufacturer’s Certificate: Certify that system has been tested and meets or exceeds specified requirements and all code requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

C. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.6 QUALITY ASSURANCE

A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install sprinkler systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).

B. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities, including those of the State of Connecticut, State Fire Marshall, local ordinances and OSHA. Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.

C. In addition to complying with the above codes and regulations, comply with the requirements of the following:
1. NFPA Standard 13.
2. NFPA Standard 24.
3. State Building and Fire Codes.
4. Local Jurisdictional Authorities.

D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

E. Valves: Bear UL and/or FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

F. All items of similar class shall be the products of the same manufacturer. All valves, accessory items, etc., shall be from the same source.

G. Maintain one copy of each applicable NFPA standard on site.

H. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

I. Installer: Company specializing in performing work of this Section with minimum five years experience.

J. Design sprinkler system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State where the project is located.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Deliver and store products in shipping containers, with labeling in place.

C. All equipment, valves, gages and etc., shall be covered and protected during the execution of the work. All equipment and piping shall be protected from freezing. Labeling to remain in place.

D. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.

E. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for

1.11 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish extra sprinklers under provisions of NFPA 13.

C. Furnish suitable wrenches for each sprinkler type.

D. Provide metal storage cabinet adjacent to the sprinkler riser.

PART 2 PRODUCTS

2.1 SPRINKLERS

A. Manufacturers:
1. Viking.
2. Tyco.
3. Victaulic.
4. Grinnell Corp.
5. Reliable Sprinkler Corp.
6. Substitutions: Section 01 60 00 - Product Requirements

B. All sprinklers shall be adjustable, glass bulb, automatic sprinklers with ½ inch orifice and 5.6 K-factor unless noted otherwise. Type of sprinkler head shall be as indicated on the plans and in accordance with the following.

C. Sprinkler bodies shall be die-cast brass, with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation.

D. Unless noted otherwise, ordinary temperature rated sprinkler heads shall be used throughout the building.

E. Where sprinklers will be installed in close proximity to heat sources and special locations, as identified in NFPA 13, temperature ratings shall be in accordance with the requirements of NFPA 13

F. Where plans call for extended coverage sprinkler heads coordinate coverage requirements with required pressure and K-factor.

G. Spare Sprinklers: The Sprinkler Contractor shall furnish spare automatic sprinklers in accordance with the requirements of NFPA for stock of extra sprinklers. The sprinklers shall be packed in a suitable container and shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. The Sprinkler Contractor shall furnish no less than two special sprinkler wrenches, or at least one wrench for each container or sprinkler box, whichever is greater.

H. In areas where sprinkler heads are subject to physical damage, provide sprinkler guard assembly over head, finish to match sprinkler finish. This shall include but not limited to the following locations.
1. Heads in elevator shafts.
2. Heads under lower rakes of stairways.
3. Heads in electrical rooms, boiler rooms and other mechanical rooms.
4. Heads installed 7’-0” or less above finished floors.
5. Heads in gymnasium/fitness center areas.

I. Sprinklers shall be in accordance with the following table:

Sprinkler Type	**Sprinkler Finish**	**Manufacturer/Model Number**
Quick-response Pendant and Upright Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V2708 and V2704.
Quick-response Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V2710.
Quick-response Concealed Type Sprinklers	Brass finish with factory painted white cover plate.	Victaulic Model V3802.
Window type sprinklers (water curtain)	Chrome plated finish, pendent type vertical sidewall style.	Tyco model WS, 5.6K-factor
Extended Coverage, Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3415.

Dry Pendant Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3607.
Dry Horizontal Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3609.
Quick-response Dry Pendant Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3608.
Quick-response Dry Horizontal Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3610.

2.2 ALARM CHECK VALVES

A. Manufacturers:
1. Viking.
2. Tyco.
3. Victaulic.
4. Grinnell Corp.
5. Reliable Sprinkler Corp.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Wet Pipe Alarm Valve:
1. Check type valve with Nitrile seat o-ring aluminum bronze clapper with EPDM seal to automatically actuate electrically and hydraulically operated alarms, with pressure retard chamber and variable pressure trim. Valve internal components shall be replaceable without removing valve from the installed position. Valve shall be Series 751 as manufactured by Victaulic Co or engineer approved equal.
2. Provide retard chamber as part of wet alarm valve trim to allow for pressure fluctuations. Retard chamber shall be Victaulic Series 752 or engineer approved equal by manufacturers listed above. Provide all other trim as recommended by the manufacturer.
3. Alarm check valve assembly shall allow discharge of one or more sprinklers to activate electric and hydraulic alarms.

2.3 PIPING SPECIALTIES

A. Manufacturers:
1. Potter.
2. Potter-Roemer.
3. System Sensor.
4. Victaulic.
5. Viking.

B. Electric Alarm: Electrically operated red enameled chrome plated gong with pressure alarm switch, 120 volt with weatherproof back box.

C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two form C contacts; rated 10 amp at 120 volt.

D. Valve Tamper Supervisory Switch: Two form C contacts; rated 10 amp at 120 volt. UL listed and FM approved. Up to 2” – Potter Model PCVS-1. Over 2" switch shall be Potter Model OSYSU-2.

E. Pressure Switch: ½ inch male pressure connection to alarm valve riser and actuated by any flow of water in excess of one sprinkler. Maximum pressure rating 175 psi, weather-proof with tamper resistant screws, rated 10 amps at 120 volt.

F. Pressure Gage: Rated for 300 psi use, 3-1/2” in diameter.

2.4 FIRE DEPARTMENT CONNECTION

A. Fire department connection shall be 2-1/2”x2-1/2”x4”, polished brass, single clapper siamese type pedestal connection. Provide with polished brass identification plate.

B. Clapper design shall allow for one or both inlets to be pressurized during operation.

C. Provide polished brass cast aluminum alloy caps and chains for protection of the 2-1/2” inlets.

D. The fire department connection shall be constructed of cast brass with brass clapper, brass swivel couplings and a brass hinge pin. The words “AUTO SPKR” and “F.D. Conn” shall be cast in raised letters on the body.

E. Fire department connection threads shall match the local fire departments standard.

F. Drain: 3/4 inch automatic drip, install at low point after check valve, pipe to building exterior.

G. Label: "Manual Standpipe/ Wet Sprinkler Sprinkler” - Fire Department Connection".

H. Provide a 90-degree elbow with drain connection at each fire department connection to allow for drainage in areas exposed to the building exterior to prevent freezing. Elbow shall be Victaulic #10-DR.

PART 3 EXECUTION

3.1 PREPERATION

A. Coordinate work of this Section with other affected work.

B. Prepare piping connections to equipment with grooved joint couplings, flanges, or unions.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturers instructions.

B. Install fire protection systems in accordance with NFPA 13 for sprinkler systems, and NFPA 24 for service mains.

C. The Contractor shall provide a complete and fully code compliant fire suppression system throughout the entire building.

D. The Contractor shall notify the owner's representative before impairing any fire protection equipment.

E. The Contractor shall maintain a clean and orderly site during the installation of the sprinkler system. Materials shall not be stored in the halls or other public areas.

F. Cutting, welding and other hot work shall not be permitted without permission from the building owner. Contractor shall provide a fire watch for one hour after all welding

G. The required tests shall be witnessed by the Fire Marshall, authority having jurisdiction, Owner's insurance underwriter and Architect/Engineer.

H. Provide reduced pressure backflow preventer assembly Double check valve assembly at with detector check assembly sprinkler system water source connection. Install a drain line from the air gap fitting and terminate at the nearest floor drain. The backflow preventer shall be installed at a minimum height to allow installation of the air gap fitting, but shall not be installed at more than 5'0" above finished floor for maintenance.

I. Locate fire department connection with sufficient clearance from walls, obstructions, etc., to allow full swing of fire department wrench handle. Coordinate the exact location of the fire department connection with the local fire officials. Installation shall conform to the local fire official's requirements.

J. Installation of Alarm Valves: Install a drain line from the drain connection to the nearest floor drain. Install a test line from the test connection to the exterior of the building. Provide a splash block. Provide gate valves at each line. Minimum alarm valve riser shall be 4-inch.

K. Locate outside alarm bell on building wall.

L. Center heads in two directions in ceiling tile and provide piping offsets as required. one direction only in ceiling tile with location in other direction variable, dependent upon spacing and coordination with ceiling elements.

M. Where ceilings or ceiling features permit the passage of heat from one plane or elevation to another, the contractor shall provide sprinklers both at the lower ceiling level and above the lower ceiling or feature level or plane. Refer to architectural drawings for ceiling types and locations.

N. Sprinkler Bulb protector must remain in place until the sprinkler is completely installed. Remove the bulb protector by hand after installation and before the system is placed in service. (Do not use any tools to remove the bulb protector.)

O. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

P. Coordinate flow switches, tamper switches, and all other sprinkler devices with the fire alarm system.

Q. Provide wire guards on sprinklers as indicated on drawings.

R. Place pipe runs to minimize obstruction to other work.

S. Install piping in concealed spaces above finished ceilings.

T. Hydrostatically test entire system in accordance with the requirements of NFPA 13 (?).

U. Require test be witnessed by Fire Marshall. Authority having jurisdiction. Owner's insurance underwriter. Architect/Engineer.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Verify signal devices are installed and connected to fire alarm system.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements:Final cleaning.

B. Flush entire piping system of foreign matter.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish. Remove after painting. Replace painted sprinklers with new.

3.6 IDENTIFICATION

A. Provide and apply signs to control, drain, test and alarm valves to identify their purpose and function. Provide and permanently attach hydraulic calculations data nameplate at the controlling valve for the sprinkler system. Provide lettering size and style from NFPA’s suggested styles.

3.7 TESTING

A. Section 21 05 00 - Common Work Results for Fire Suppression.

END OF SECTION

SECTION 220400 - GENERAL CONDITIONS FOR PLUMBING TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This section applies to certain sections of Division 26, "Electrical," and this section applies to all sections of Division 22, "Plumbing" of this project specification unless specified otherwise in the individual sections.

1.2 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

1.3 INTENT

A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.

B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.

C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.

D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

1.4 DEFINITIONS

A. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.

B. “Approved equal” mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.

C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

D. “Finished” refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.

E. “Furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.

F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

G. “Install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.

H. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.

I. “Provide” shall mean furnish (or supply) and install as necessary.

J. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

K. Remove: The term “remove” means “ to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”

L. Special Warranties: The term “Special Warranties” are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

M. Standard Product Warranties: The term “Standard Product Warranties” are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

N. “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Plumbing Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.

O. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."

P. “Wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

1.5 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.

D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.6 SURVEYS AND MEASUREMENTS

A. Before submitting his Bid, the Contractors shall visit the site and become thoroughly familiar with all existing conditions under which work will be installed. This Contract includes all modifications of existing systems required for the installation of new equipment. This Contract includes all necessary offsets, transitions and modifications required to install all new equipment in existing spaces. All new and existing equipment and systems shall be fully operational under this Contract before the job is considered complete. The Contractors shall be held responsible for any assumptions he makes, any omissions or errors he makes as a result of his failure to become fully familiar with the existing conditions at the site and the Contract Documents.

B. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

D. The Contractor shall review the entire project Architectural, Site/Civil, Kitchen (Food Service) Electrical and Mechanical and Equipment drawings and specifications for coordination items and or piping, fixtures and trim to be furnished by or installed by the plumbing contractor. Any additional work items shall be furnished and installed at no additional cost to the owner.

1.7 CODES AND STANDARDS

A. Reference Standard Compliance
1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

B. The Following Codes and Standards listed below apply to all mechanical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:
Connecticut State Building Code - Connecticut Supplement
The International Building Code
The International Mechanical Code
The International Plumbing Code
The International Energy Conservation Code
The National Electrical Code
NFPA 101 Life Safety
ASHRAE 90.1 and International Energy Conservation Code

C. The following Standards shall be used where referenced by the following abbreviations:

ACGIH	American Conference of Governmental Industrial Hygienists
AGA	American Gas Association
AIA	American Institute of Architects
ANSI	American National Standards Institute
API	American Petroleum Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CGA	Compressed Gas Association
CSA	Canadian Standards Association
CISPI	Cast Iron Soil Pipe Institute
EJMA	Expansion Joint Manufacturing Association
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
HIS	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	Insurance Services Office
MCAA	Mechanical Contractors Association of America

NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NOFI	National Oil Fuel Institute
NSC	National Safety Council
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SBI	Steel Boiler Industry (Division of Hydronics Institute)
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
STI	Steel Tank Institute
UL	Underwriters' Laboratories

D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.

E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.8 PERMITS AND FEES

A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.9 EQUIPMENT SUBSTITUTIONS

A. In these Contract Documents, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. These describe the basis of design and approved equivalents. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation without consideration of any or all costs associated but not limited to (structural, mechanical, or electrical feeder, breaker, or transformer requirements). The Contractor acknowledges that not all requirements are shown for either alternate acceptable manufacturers listed or those alternates requiring a request for substitution and it is their responsibility to coordinate all requirements necessary to accommodate any change from the basis of design listed or scheduled. The contractor is required to submit any and all costs (including costs associated or required by all trades) along with performance differences as part of their request for substitution. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.

B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineers review.

C. Where two or more names are given as approved manufacturers of equivalents, the Contractor must use the specified item or one of the named equivalents which still must meet all of the performance characteristics of the basis of design make and model. Where one name only is used and is followed by the words “or approved equal”, the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.

D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the equipment or materials as hereinafter specified, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.

E. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Engineers/Architects of Record at the expense of the Contractor and at no additional cost to the Owner.

F. Where such accepted deviation resulting from using an approved equivalent or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, after acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the deviation.

G. Equipment, material or devices submitted for review as an “equivalent” shall meet the following requirements:
   1. The equivalent shall have the same construction features such as, but not limited to:
      a. Material thickness, gauge, weight, density, etc.
      b. Welded, riveted, bolted, etc., construction
      c. Finish, undercoating, corrosion protection
   2. The equivalent shall perform with the same or better operating efficiency.
   3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
   4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.

H. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:
   1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
   2. Submit three (3) copies of each request for substitution for consideration.
   3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete

documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:

a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
b. Samples, where applicable or requested.
c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will become necessary to accommodate the proposed substitution.
e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
f. Cost information, including a proposal of the net change, if any in the Contract Sum.
g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.
h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
    1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.
    2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
    3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.10 SUBMITTAL PROCEDURES

A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
   1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
   2. If an intermediate submittal is necessary, process the same as the initial submittal.
   3. Allow two weeks for reprocessing each submittal.
   4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
   1. Include the following information on the label for processing and recording action taken.
      a. Project name.
      b. Date.
      c. Name and address of Engineer.
      d. Name and address of Contractor.
      e. Name and address of subcontractor.
      f. Name and address of supplier.
      g. Name of manufacturer.
      h. Number, title and paragraph of appropriate Specification Section.
      i. Drawing number and detail references, as appropriate.

E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.

G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

1.11 SHOP DRAWINGS

A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Mechanical Contract. Refer to Division 1 for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.

C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, fire protection, etc.

E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.

G. "No Exception Taken" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.

H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.

I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.

J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.

K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

L. Prepare sheetmetal and sprinkler shop drawings drawn in the latest AutoCAD version to a minimum scale of 1/4” = 1’- 0”. Final approved drawings shall be turned over to the Owner on floppy disk or CD Rom.

1.12 COORDINATION DRAWINGS

A. Prepare coordination drawings drawn in the latest AutoCAD version in accordance with Division 1 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
   a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
   b. Equipment connections and support details.
   c. Exterior wall and foundation penetrations.
   d. Fire-rated wall and floor penetrations.
   e. Sizes and locations of required concrete pads and bases.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

E. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.

F. Work shall not be performed until coordination drawings have been approved by the architect and engineer.

G. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. The cost for these floor plans is a lump sum fee of $ 500.00. If the Contractor elects to obtain the Engineers electronic files a CADD File Release Form must be submitted with payment. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the CADD File Release Form, and payment, the Engineer will provide copies of the electronic files for the Contractor’s use. A copy of the CADD File Release Form is appended to the end of this specification section

1.13 COORDINATION WITH OTHER DIVISIONS

A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular

emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.

B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.

C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.

D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

E. The Plumbing Contractor shall coordinate with the electrical contractor, so that all plumbing fixtures, trim, equipment, devices, accessories, panels, alarms etc are provided with the correct power supply. All items noted shall be furnished with power at no additional cost to the owner.

1.14 WORKMANSHIP

A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

E. All labor for installation of plumbing systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.15 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.

B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that operating services will be shut down only during the time actually required to make necessary connections.

1.16 TEMPORARY UTILITIES

A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

C. First Aid Supplies: Comply with governing regulations.

D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.

E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
   1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.

F. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.

G. Temporary Heat-Cool-Dehumidification: Provide temporary services required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate temporary services to produce the ambient condition required and minimize consumption of energy. The building’s permanent HVAC systems shall not be used for these purposes.

H. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful

noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

I. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when 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 the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.17 PROJECT PHASING

A. Work under each Section shall include all necessary temporary connections, equipment, piping, heating, temperature control work, fire stopping, water heaters, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All existing systems that pass-thru an area of the building shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required to maintain existing systems operational or to accommodate the construction phasing of the project.

1.18 PROTECTION OF MATERIALS AND EQUIPMENT

A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.

B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.

D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.19 ADJUSTING AND TESTING

A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.

B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the

initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing, that the equipment was installed according to manufacturers recommendations and is operating as intended by the manufacturer.

1.20 CLEANING

A. The Contractor shall thoroughly clean and flush all piping and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.

B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

C. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.

D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.

E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
   1. Remove labels that are not permanent labels.
   2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
   3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
   4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.

F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.

G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.21 OPERATING AND MAINTENANCE

A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner’s representative in the operation, adjustment and maintenance of all equipment furnished. The

Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.

C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.

D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; air conditioning equipment, controls, air handling equipment, compressors, boilers etc. These letters shall be bound into the operating and maintenance books.

E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

F. Demonstration shall be recorded on VHS audio/video tape with two (2) tapes turned over to the Owner.

1.22 OPERATING AND MAINTENANCE MANUALS

A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.

B. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing and operating instructions including lubrication charts and schedules.
5. Emergency and safety instructions.
6. Spare parts list.
7. Copies of warranties.
8. Wiring diagrams.
9. Recommended "turn around" cycles.
10. Inspection procedures.
11. Approved Shop Drawings and Product Data.
12. Equipment Start-up Reports.
13. Temperature control diagrams and written sequences of operations.
14. Balance reports.

C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.

D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.23 ACCEPTANCES

A. The equipment, materials, workmanship, design and arrangement of all work installed under the Mechanical Sections shall be subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, the Plumbing Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Plumbing Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.

C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner’s representative.

D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Plumbing Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.

F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.24 RECORD DRAWINGS

A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that

would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:

1. Dimensional change
2. Revision to drawing detail
3. Location and depth of underground utility
4. Revision to pipe routing
5. Revision to electrical circuitry
6. Actual equipment location
7. Pipe size and routing
8. Location of concealed internal utility
9. Changes made by Change Order
10. Details not on original Contract Drawing
11. Information on concealed elements which would be difficult to identify or measure later

C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.

D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.

E. Note related Change Order numbers where applicable.

F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

G. These shall be clearly marked for Record Drawings on a clean set of reproducible mylar sepias at the completion of the work and turned over to the Owner.

H. Final record documents shall be prepared in the latest AutoCad version and floppy disks or CD Rom of all drawings and a clean set of reproducible mylar sepias shall be turned over to the Owner at the completion of the work.

1.25 WARRANTIES AND BONDS

A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:

1. General close-out requirements included in Division 1.
2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions-2 through -16.
3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.26 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
   1. Refer to individual Sections of Divisions-2 through -16 for specific content requirements, and particular requirements for submittal of special warranties.

J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
   1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the 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 the installer.
   2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
   3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.27 GUARANTEES

A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.

B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

1.28 PROJECT CLOSE-OUT

A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents in accordance with Division 1.

B. Deliver tools, spare parts, extra stock, and similar items.

C. Complete start-up testing of systems, including measuring and documenting all required startup checklist requirements documented in installation and maintenance instructions by the equipment manufacturer, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

D. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

E. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
   1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.
   2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION

CADD File Release Form

DELIVERY OF CADD FILES FOR: _____
Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ _____
Client's Signature Date

_____
Company - Title

_____ _____
Architects' Signature Date

_____
Firm - Title

_____ _____
Owner's Signature Date

_____
Company - Title

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Identification for Plumbing Piping and Equipment.
2. Sleeves.
3. Mechanical sleeve seals.
4. Formed steel channel.

1.2 SUBMITTALS

A. Shop Drawings: Submit for piping and equipment identification list of wording, symbols, letter size, and color coding for pipe identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

B. Product Data for Pipe and Equipment Identification: Submit for mechanical identification manufacturers catalog literature for each product required.

1.3 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

PART 2 PRODUCTS

2.1 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

A. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light background color.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light background color, minimum 1-1/2 inches diameter.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Color and Lettering: Conform to ASME A13.1.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Color and Lettering: Conform to ASME A13.1.

E. Plastic Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.2 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sealant: Acrylic; refer to Section 07 90 00.

2.3 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. Substitutions: Permitted.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.4 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Unistrut Corp.
4. Substitutions: Permitted.

B. Product Description:Galvanized 12 gage) thick steel. With holes 1-1/2 inches on center.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION - PIPING AND EQUIPMENT IDENTIFICATION

A. Install plastic nameplates with rivets for equipment and devices located outside the building.

B. Install plastic nameplates with adhesive for equipment and devices located inside the building.

C. Install plastic tags with corrosion resistant metal chain.

3.3 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with stuffing firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install chrome plated steel plastic stainless steel escutcheons at finished surfaces.

END OF SECTION

SECTION 220503 - PIPES AND TUBES FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Pipe and pipe fittings for the following systems:
1. Domestic water piping, [within] 5 feet of building].
2. Sanitary sewer piping, [within] 5 feet of building].
3. Chemical resistant sewer piping.
4. Storm water piping, [within] 5 feet of building].
5. Equipment drains and over flows.
6. Compressed air piping.
7. Unions and flanges.
8. Underground pipe markers.
9. Bedding and cover materials.

B. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 - Access Doors and Frames
3. Section 09 90 00 - Painting and Coating
4. Section 22 04 00 – General Conditions for Plumbing Trades
5. Section 22 05 00 – Common work results for Plumbing
6. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
7. Section 22 05 23 - General-Duty Valves for Plumbing Piping
8. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
9. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
10. Section 22 05 53 – Identification for Plumbing Piping and Equipment
11. Section 22 07 00 - Plumbing Insulation
12. Section 22 15 00 – Specialty Plumbing Systems and Equipment
13. Section 22 30 00 – Plumbing Specialties
14. Section 22 34 00 – Fuel Fired Domestic Water Heaters
15. Section 22 40 00 – Plumbing Fixtures

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.3 - Malleable Iron Threaded Fittings.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
6. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
7. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
8. ASME B31.9 - Building Services Piping.
9. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
10. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:

1. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
2. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
3. ASTM A536 - Standard Specification for Ductile Iron Castings.
4. ASTM B32 - Standard Specification for Solder Metal.
5. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
6. ASTM B75 - Standard Specification for Seamless Copper Tube.
7. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
8. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
9. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes.
10. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
11. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
12. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
13. ASTM C1053 - Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
14. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
15. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
16. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
17. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
18. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
19. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
20. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
21. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
22. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
23. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
24. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
25. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
26. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
27. ASTM F679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
28. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Welding Society:
   1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
   2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:
   1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
   3. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
   4. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   5. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
   6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.

E. Cast Iron Soil Pipe Institute:
   1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   2. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

F. NSF International:
   1. NSF 61 - Standard for Drinking Water System Components - Health Effects.

G. Safe Drinking Water Act.
   1. SDWA 1417 - Standard for Lead Free Drinking Water.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, and sizes. [Submit shop drawings sealed by registered professional engineer.]

C. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information. Clearly indicate on submittal "Lead Free" where required.

D. Design Data: Indicate pipe sizes. Indicate pipe sizing methods. Indicate calculations used. [Submit [sizing methods] [calculations] sealed by registered professional engineer.]

E. Welders' Certificate: Include welders' certification of compliance with [ASME Section IX.] [AWS D1.1.]

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. All cast iron soil pipe and fittings shall be marked with the collective trademark of the cast iron soil pipe institute.

C. All couplings for hubless cast iron soil pipe and fittings shall meet the requirements of CISPI 310 and be certified by NSF International.

D. All components of the potable domestic water system shall meet the requirements of SDWA-1417.

E. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic or an Engineer Approved Equal . Grooving tools shall be supplied by the same manufacturer as the grooved components

F. Maintain [one copy] copies] of [each] document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum [three] years [documented] experience.

B. Installer: Company specializing in performing work of this section [with minimum years [documented] experience] [].

C. Design [piping systems] [pipe hangers and supports] under direct supervision of Professional Engineer experienced in design of this Work and licensed [at Project location.]

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum [one] week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Do not install underground piping when bedding is wet or frozen.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate installation of buried piping with trenching.

PART 2 PRODUCTS

2.1 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Water Service Ductile Iron Pipe: AWWA [C151] [C104]
1. Fittings: AWWA C110, [ductile] iron, standard thickness.
2. Joints: AWWA C111, rubber gasket with rods.
3. Jackets: [AWWA C105 polyethylene jacket] [].

B. Buried Supply to fixtures or devices: Copper Tubing: [ASTM B88], Type [K,] annealed.
1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
2. Joints: Compression connection or Brazed, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

C. Buried piping from trap primer: Polyethylene Pipe: ASTM D2239 SIDR 19, or ASTM D2447 Schedule 40.
1. Fittings: ASTM D2609, Polyethylene.
2. Joints: Mechanical with stainless steel clamps.

D. Domestic water piping buried for future use: High Density Polyethylene Pipe (HDPE): ASTM D 2239, AWWA C901.
1. Joints: ASTM D2239 double clamped.

2.2 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tubing: [ASTM B88], Type [L,] drawn.
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
2. Joints: [ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder [AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.]

B. Copper Tubing: [ASTM B88], Type [L,] drawn, rolled grooved ends.
1. Fittings: [ASME B16.18 cast copper alloy,] [or] [ASME B16.22 wrought copper and bronze,] [or] [ASTM B584 bronze sand castings,] grooved ends.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.
a. Housing Clamps: Installation-Ready ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock. Cast with angled pattern bolt pads to assure rigidity upon visual confirmation of metal-to-metal bolt pad contact with no torque requirement.
b. Gasket: EHP EPDM Elastomer composition for operating temperature range from -30 degrees F to 180 degrees F.
c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type L, drawn.
1. Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper and bronze or extruded tee connections conforming to ASTM F2014-00.

2. Joints: ASTM B32, solder, Grade 95TA or extruded tee connections brazed in compliance with the manufacturer's written instructions.
3. Other Acceptable Joining Methods:
   a. Victaulic Copper Connection System sizes 2" to 8" with Victaulic style 607 coupling for copper tubing.
      1) Grooved Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper, with copper-tubing sized grooved ends. (Flaring of tube or fittings ends to IPS sizes is not permitted.
      2) Style 607 coupling with offsetting, angle-pattern bolt pads for direct metal-to-metal bolt pad contact with no torque requirement.
      3) Gaskets shall be grade 'EHP' EPDM, UL classified in accordance with ANSI/NSF-61 for potable water service.
   b. Press Fitting: Copper and copper alloy press fittings conforming to ASME B16.18 or ASME B16.22. Sealing elements for press fittings shall be EPDM and factory installed. Press ends shall have SC feature design (leakage path) to assure detection and easy identification of leakage of liquids from inside the system past the sealing element of an unpressed connection.

2.3 DOMESTIC WATER PIPING, ABOVE GRADE (Press Style Fittings)

A. Copper Tubing: ASTM B88, Type L, drawn.
   1. Press Fittings: IAPMO PS 117, ANSI LC1002, NSF61-G, EPDM sealing element and leak detection feature.

2.4 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot solvent sealed ends.
   1. Fittings: PVC, ASTM D2729.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.5 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hub-less, service weight.
   1. Fittings: Cast iron, CISPI 301.
   2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.6 CHEMICAL RESISTANT SEWER PIPING

A. PVC Pipe: ASTM D2729 or ASTM D2665, polyvinyl chloride (PVC) material.
   1. Fittings: PVC, ASTM D2729 or ASTM D2665.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

B. Glass Pipe: ASTM C1053, borosilicate glass material.
   1. Fittings: ASTM C1053, borosilicate glass.
   2. Joints: Stainless steel compression couplings with tetra-fluoroethylene seal ring.

C. PP Pipe: Polypropylene .
   1. Fittings: Polypropylene.
   2. Joints: Electrical resistance fusion.

2.7 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665 or ASTM D3034 SDR 26, polyvinyl chloride (PVC) material.
1. Fittings: PVC, ASTM D2665 or ASTM D3034.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

B. PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679, polyvinyl chloride (PVC) material.
1. Fittings: PVC, ASTM D2665, ASTM D3034, or ASTM F679.
2. Joints: ASTM F477, elastomeric gaskets.

2.8 STORM WATER PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74 [service] weight, [plain] ends.
1. Fittings: Cast iron, ASTM A74.
2. Joints: ASTM C564, neoprene gasket system or lead and oakum.

2.9 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
1. Ferrous Piping: Class [150] , malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with [soldered] [brazed joints].
3. Dielectric Connections: Union or waterways with galvanized or plated steel or copper-silicon casting with threaded end, copper solder end, grooved end, lead free, water impervious isolation barrier.
4. PVC Piping: PVC.
5. CPVC Piping: CPVC.

B. Flanges for Pipe 2-1/2 inches and Larger:
1. Ferrous Piping: Class [150] [], forged steel, slip-on flanges or grooved joint flange adapters.
2. Copper Piping: Class 150, slip-on bronze flanges or grooved joint flange adapters.
3. PVC Piping: PVC flanges.
4. CPVC Piping: CPVC flanges.
5. Gaskets: 1/16 inch thick preformed neoprene gaskets.
6. Dielectric Connections: Waterways with galvanized or plated steel or copper-silicon casting with grooved end, lead free, water impervious isolation barrier

C. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

2.10 UNDERGROUND PIPE MARKERS

A. Manufacturers:
1. Seton
2. Northtown
3. Kolbi
4. Substitutions: [Section 01 60 00 - Product Requirements.

B. Trace Wire: Magnetic detectable conductor, [brightly colored] plastic covering, imprinted with "[Domestic Water Service] [Sewer Service] in large letters.

2.11 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type [A1] [A2] [A3] [A4] as specified in Section [31 05 16]

B. Cover: Fill Type [A1] [A2] [A3] [A4], as specified in Section [31 05 16]

C. Soil Backfill from Above Pipe to Finish Grade: Soil Type [S1] [S2], as specified in Section [31 05 13] [Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.]

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify excavations are to required grade, dry, and not over-excavated.

C. Verify trenches are ready to receive piping.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. [Bevel or groove plain end ferrous pipe.]

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

A. Establish elevations of buried piping beyond building foot print with not less than three ft of cover for buried storm and sanitary and 48” of cover for buried domestic water supplies.

B. Excavate pipe trench in accordance with Section [31 23 17]

C. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding [4] inches [loose] depth; .

D. Install pipe on prepared bedding.

E. Route pipe in straight line.

F. Install pipe to allow for expansion and contraction without stressing pipe or joints.

G. Install [shutoff] [and] [drain] valves at locations indicated on Drawings in accordance with [] [Section [22 05 23]

H. Install trace wire continuous over top of pipe when PVC piping is installed below grade..

I. Pipe Cover and Backfilling:
   1. Backfill trench in accordance with Section [31 23 23.]
   2. Maintain optimum moisture content of fill material to attain required compaction density.
   3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in [6] inches compacted layers to [6] inches minimum cover over top of jacket. Compact to [95] percent maximum density.
   4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
   5. Do not use wheeled or tracked vehicles for tamping.

3.4 INSTALLATION - ABOVE GROUND PIPING

A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 05 29.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.

G. Provide access where valves and fittings are not accessible. [Coordinate size and location of access doors with Section 08 31 13.]

H. Install non-conducting dielectric connections wherever jointing dissimilar metals.

I. Establish invert elevations, slopes for drainage to [1/4] [1/8] inch per foot minimum. Maintain gradients.

J. Slope piping and arrange systems to drain at low points.

K. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

L. Install piping penetrating roofed areas to maintain integrity of roof assembly.

M. Install valves in accordance with Section 22 05 23.

N. Install piping specialties in accordance with Section 23 21 16.

O. Insulate piping. Refer to Section 22 07 00.

P. Install pipe identification in accordance with Section 22 05 53.

Q. The plumbing contractor shall furnish and install hot and cold water supplies to all plumbing fixtures and equipment throughout the project. All piping shall be supplied from the water source, mains, and branch piping.

R. Shut off valves shall be provided on all supply piping where more than two fixtures are provided. Valve type shall be as determined by the engineer or as indicated on the drawings and specifications.

3.5 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

A. Install domestic water piping system in accordance with SDWA - 1417.

B. Install domestic water piping system in accordance with ASME B31.9.

3.6 INSTALLATION – PRESS STYLE FITTINGS

A. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) recommended by the manufacturer. Contractor shall be trained on the use and installation of the system by manufacturer's representative.

3.7 INSTALLATION - SANITARY WASTE AND VENT PIPING SYSTEMS

A. Install sanitary waste and vent piping systems in accordance with ASME B31.9.

B. Install sanitary waste and vent piping systems in accordance with [local] plumbing code.

C. Install bell and spigot pipe with bell end upstream.

D. Support cast iron drainage piping at every joint.

E. Sanitary and vent piping shall be provided for all plumbing fixtures, devices and equipment throughout the project. All piping shall be installed in compliance with the adopted edition of the international Plumbing Code and State of Connecticut Amendments and Supplements.

F. Vents from individual fixtures shall be combined and extend through the roof in multiple locations. Vent terminations at the roof shall not be installed within 25' of fresh air intakes for mechanical equipment.

G. Sanitary piping from individual fixtures, devices and equipment shall combine into multiple buried laterals and exit the building below finished grade and connect to the one site piping network.

H. The plumbing contractor must review the site and civil drawings for coordination with piping systems beyond the building footprint.

I. Furnish and install cleanouts at all changes in direction greater than 45 degrees and not more than 75' foot intervals for horizontal runs. Provide finished grade cleanouts at lateral exiting the building.

J. The project includes multiple approved techniques for venting, including but not limited to wet venting, circuit venting, combination drain and vent and island fixture vents. The contractor shall install the vent system accordingly to comply with the adopted edition of the International Plumbing Code.

3.8 INSTALLATION - STORM DRAINAGE PIPING SYSTEMS

A. Install storm drainage piping systems piping in accordance with ASME B31.9.

B. Install storm drainage piping systems in accordance with [local] plumbing code.

C. Install bell and spigot pipe with bell end upstream.

D. Support cast iron drainage piping at every joint.

E. Storm piping shall be furnished and installed to all roof drains, overflow drains and canopy drains throughout the project and shall be combined and exit the building below finished grade in multiple locations.

F. Furnish and install cleanouts at all changes in direction greater than 45 degrees and not more than 75’ foot intervals for horizontal runs. Provide finished grade cleanouts at lateral exiting the building.

G. The plumbing contractor must review the site and civil drawings for coordination with piping systems beyond the building footprint.

3.9 INSTALLATION - COMPRESSED AIR PIPING SYSTEMS

A. Install compressed air piping systems piping in accordance with ASME B31.9.

B. Install drip connections with valves at low points of piping system.

C. Install take-off to outlets from top of main, with shut off valve after take off. Slope take-off piping to outlets.

D. Install compressed air couplings, female quick connectors, and pressure gages [where outlets are indicated] [as indicated on Drawings].

E. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.

F. Cut pipe and tubing accurately and install without springing or forcing.

G. Slope piping in direction of flow.

H. Install strainers on inlet side of pressure reducing valves. Install pressure reducing valves with bypasses and isolation valves to allow maintenance without interruption of service.

3.10 FIELD QUALITY CONTROL

A. Section [01 40 00 - Quality Requirements] [01 70 00 - Execution and Closeout Requirements]: Field inspecting, testing, adjusting, and balancing.

B. Test domestic water piping system in accordance with [applicable code] [local authority having jurisdiction]

C. Pressure test to identify un-pressed fittings: Utilizing air or water, the system shall be pressurized, not to exceed 85 psi. If there is a significant drop in pressure, the system shall be walked to check for un-pressed fittings. Should an un-pressed fitting be located, the pressure should be released from the system and the un-pressed fitting shall be pressed. If no un-pressed fitting is identified the system shall be pressurized to test pressures required by code, not to exceed 600 psi.

D. Test sanitary waste and vent piping system in accordance with [applicable code] [local authority having jurisdiction]

E. Test storm drainage piping system in accordance with [applicable code] [local authority having jurisdiction]

F. Test for Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.9.

3.11 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Clean and disinfect domestic water distribution system in accordance with Section [22 11 00] [33 13 00]

END OF SECTION

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

A. Section Includes:
1. Flexible pipe connectors.
2. Expansion joints.
3. Expansion compensators.
4. Pipe alignment guides.
5. Swivel joints.
6. Pipe anchors.

B. Related Sections:
1. Section 22 04 00 – General Conditions for Plumbing Trades
2. Section 22 05 00 – Common work results for Plumbing
3. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
4. Section 22 05 23 - General-Duty Valves for Plumbing Piping
5. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
6. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
7. Section 22 05 53 – Identification for Plumbing Piping and Equipment
8. Section 22 07 00 - Plumbing Insulation
9. Section 22 15 00 – Specialty Plumbing Systems and Equipment
10. Section 22 30 00 – Plumbing Specialties
11. Section 22 34 00 – Fuel Fired Domestic Water Heaters
12. Section 22 40 00 – Plumbing Fixtures

1.3 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.9 - Building Services Piping.
2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

1.4 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Expansion Compensation Design Criteria:
1. Installation Temperature: 50 degrees F.
2. Domestic Hot Water: 140 degrees F.

3. Safety Factor: 30 percent.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered professional engineer.

C. Product Data:
1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

D. Design Data: Indicate criteria and show calculations. Submit sizing methods and calculations sealed by a registered professional engineer.

E. Manufacturer's Installation Instructions: Submit special procedures.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX. AWS D1.1.

H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

C. Operation and Maintenance Data: Submit adjustment instructions.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.9 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for leak free performance of packed expansion joints.

1.12 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Supply two 12 ounce containers of packing lubricant and cartridge style grease gun.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:
1. Metroflex
2. Mason
3. Vibration Eliminator
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Steel Piping:
1. Inner Hose: Carbon Steel Stainless Steel Bronze.
2. Exterior Sleeve: None Single braided Double braided stainless steel bronze.
3. Pressure Rating: F 200 psig WOG and 250 degrees F
4. Joint: As specified in Section 22 05 03.
5. Size: Use pipe-sized units.
6. Maximum offset: 3/4 inch on each side of installed center line.

C. Copper Piping:
1. Inner Hose: Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint: As specified in Section 22 05 03.
5. Size: Use pipe sized units.
6. Maximum offset: 3/4 inch on each side of installed center line.

2.2 EXPANSION JOINTS

A. Manufacturers:
1. Metroflex
2. Mason
3. Vibration Eliminator
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Stainless Steel Bellows Type:
1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Maximum Compression: 1-3/4 inch.
3. Maximum Extension: 1/4 inch.
4. Joint: As specified in Section 22 05 03 .
5. Size: Use pipe sized units.
6. Application: Steel piping 3 inch and smaller.

C. External Ring Controlled Stainless Steel Bellows Type:
1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Maximum Compression: 1-1/4 inch.
3. Maximum Extension: 3/8 inch.
4. Maximum Offset: 5/16 inch.
5. Joint: Flanged.
6. Size: Use pipe sized units.
7. Accessories: Internal flow liner.
8. Application: Steel piping 3 inch and larger.

D. Double Sphere, Flexible Compensators:
1. Body: Teflon Neoprene and nylon
2. Working Pressure: 200 psi.
3. Maximum Temperature: 250 degrees F.
4. Maximum Compression: 1 inch.
5. Maximum Elongation: 5/8 inch.
6. Maximum Offset: 3/4 inch.
7. Maximum Angular Movement: 30 degrees.
8. Joint: Tapped steel flanges Galvanized flanges Galvanized unions.
9. Size: Use pipe sized units.
10. Accessories: Control rods Control cables.
11. Application: Steel piping 2 inch and larger.

E. Two-ply Bronze Bellows Type:
1. Construction: Bronze with anti-torque device, limit stops, internal guides.
2. Pressure Rating: 200 psi WOG and 250 degrees F.
3. Maximum Compression: 1-3/4 inch.
4. Maximum Extension: 1/4 inch.

5. Joint: As specified in Section 22 05 03 .
6. Size: Use pipe sized units.
7. Application: Copper piping.

F. Low Pressure Compensators with two-ply Bronze Bellows:
1. Working Pressure: 80 psig.
2. Maximum Temperatures: 250 degrees F.
3. Maximum Compression: 1/2 inch.
4. Maximum Extension: 5/32 inch.
5. Joint: Soldered.
6. Size: Use pipe sized units.
7. Application: Copper or steel piping 2 inch and smaller.

G. Copper with Packed Sliding Sleeve:
1. Maximum Temperature: 250 degrees F.
2. Joint: As specified in Section 22 05 03 .
3. Size: Use pipe sized units.
4. Copper or steel piping 2 inches and larger.
5. Application: Copper or steel piping 2 inch and larger.

2.3 ACCESSORIES

A. Manufacturers:
1. Metroflex
2. Mason
3. Vibration Eliminator
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

C. Swivel Joints:Fabricated steel Cast steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install Work in accordance with ASME B31.9

B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Refer to Section 22 05 48. Provide line size flexible connectors.

C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.

E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required as indicated on Drawings. Refer to Section 22 05 29 for pipe hanger installation requirements.

F. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.

G. Provide expansion loops as indicated on Drawings.

3.2 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers’ field services.

B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Gate valves.
2. Ball valves.
3. Butterfly valves.
4. Check valves.
5. Globe.
6. Pressure reducing.
7. Pressure relief.
8. Strainers.
9. Flow control devices.
10. Balancing valves.
11. Reduced pressure backflow preventers.
12. Thermostatic mixing valves

B. Related Sections:
1. Section 22 04 00 – General Conditions for Plumbing Trades
2. Section 22 05 03 - Pipes and Tubes for Plumbing Piping and Equipment: Product and installation requirements for piping materials applying to various system types.
3. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product and installation requirements for pipe hangers and supports.
4. Section 22 07 00 - Plumbing Insulation: Product and installation requirements for insulation for valves.

1.2 REFERENCES

A. ASTM International:
1. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
2. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

B. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 67 - Butterfly Valves.
2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

C. Safe Drinking Water Act:
1. SDWA 1417 - Reduction of Lead in Drinking Water.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of valves.

C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61.

B. All valves installed on the domestic water distribution system shall comply with SDWA 1417. Exception shall be main shut-off valve at domestic water service entrance that is 2-inches or larger.

C. All valve manufacturers shall demonstrate that valve products have been certified per NSF/ANSI Standard 372.

D. All valves installed on the domestic water system shall have labeling of lead content engraved on the valve body.

E. Maintain one copy of document on site.

F. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic or an Engineer Approved Equal

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum [three] years [documented] experience.

B. Installer: Company specializing in performing work of this section [with minimum years [documented] experience] [].

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum [one] week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Do not install valves underground when bedding is wet or frozen.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish [five] year manufacturer warranty for valves excluding packing.

1.11 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.

B. Furnish [two] packing kits for each size valve.

PART 2 PRODUCTS

2.1 GATE VALVES

A. Manufacturers:
1. Apollo
2. Milwaukee Valve Co.
3. NIBCO, Inc.
4. American Valve Co.
5. Watts
6. Substitutions: [Section 01 60 00 - Product Requirements].

B. 2 inches and Smaller: MSS SP 80, Class 300, bronze body, bronze trim, lead free, threaded bonnet, non-rising stem, hand-wheel, inside screw, solid wedge disc, solder ends, Milwaukee Valve Company Model # UP115.

C. 2 1/2 inches and Larger: MSS SP 70, Class 175, cast iron body, bronze trim, bolted bonnet, rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends, Milwaukee Valve Company F-2885-FP. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.2 BALL VALVES

A. Manufacturers:
1. Apollo
2. Milwaukee Valve Co.
3. NIBCO, Inc.
4. American Valve Co.
5. Watts
6. Substitutions: [Section 01 60 00 - Product Requirements].

B. 2 inches and Smaller: MSS SP 110, 600 psi WOG, two piece bronze body, lead free, type 316 stainless steel ball, full port, teflon seats, stainless steel blow-out proof stem, solder ends with lever handle, Milwaukee Valve Company Model #UPBA450S.

C. 2 inches and Smaller: MSS SP 110, Class 600, bronze, three piece body, lead free, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, solder ends, lever handle, Milwaukee Valve Company Model #UPBA350S.

D. 2 inches and Smaller: MSS SP 110, Class 250, bronze, two piece body, lead free, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, press ends, lever handle, Nibco Model # PC585-66-LF.

2.3 BUTTERFLY VALVES

A. Manufacturers:
1. Victaulic
2. Milwaukee Valve Company
3. NIBCO, Inc.
4. American Valve Co.
5. Watts
6. Substitutions: [Section 01 60 00 - Product Requirements.

B. 2-inches and Larger: MSS SP 67, Class 200.
1. Body: Cast bronze, lug ends, stainless steel stem, extended neck.
2. Disc: Aluminum bronze.
3. Seat: Resilient replaceable EPDM or Fluoroelastomer.
4. Handle and Operator: 10 position lever handle. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.
5. Milwaukee Valve Company Model # ML 233E.

C. 2-inches and Larger: MSS SP 67, Class 200.
1. Body: Ductile iron, lug ends, stainless steel stem, extended neck.
2. Disc: Aluminum bronze.
3. Seat: Resilient replaceable EPDM .

4. Handle and Operator: 10 position lever handle. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.
5. Lead free.
6. Milwaukee Valve Company Model # ML 233E.

D. 2-1/2 inches and Larger: MSS SP 67, 300 CWP.
1. Body: Cast bronze, grooved ends
2. Disc: Offset ductile iron
3. Seat: Resilient replaceable Flouroelastomer
4. Handle and Operator: 10 position lever handle. Furnish chain-wheel operators for valves mounted over 8 feet above floor
5. Victaulic Model #608N.

2.4 CHECK VALVES

A. Horizontal Swing Check Valves:
1. Manufacturers:
a. Apollo
b. Milwaukee Valve Co.
c. NIBCO, Inc.
d. American Valve Co.
e. Watts
f. Substitutions: [Section 01 60 00 - Product Requirements].
2. 2 inches and Smaller: MSS SP 80, Class 300, bronze body and cap, bronze seat, brass disc, solder ends, Milwaukee Valve Co. Model # 1509.
3. 2-1/2 inches and Larger: MSS SP 71, [Class 125] cast iron body, bolted cap, bronze or cast iron disc, [renewable disc seal and seat,] flanged ends.

B. Spring Loaded Check Valves:
1. Manufacturers:
a. Apollo
b. Milwaukee Valve Company
c. NIBCO, Inc.
d. American Valve Co.
e. Watts
f. Substitutions: [Section 01 60 00 - Product Requirements].
2. 2 inches and Smaller: MSS SP 80, [Class 250] bronze body, in-line spring lift check, silent closing, [Buna-N] disc, integral seat, [solder] [or] [threaded] ends.
3. 2-1/2 inches and Larger: MSS SP 125, Class 125, lead free, wafer style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends, Nibco Model # F-910-LF.

2.5 GLOBE VALVES

A. Up to and including 2-inch:
1. Bronze body, bronze trim, screwed bonnet, non-asbestos packing, rising stem, handwheel, inside screw, renewable composition disc and bronze seat, Class 125,

B. Over 2-inch:
   1. Iron body, bronze trim, bolted bonnet, rising stem, non-asbestos packing, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, Class 125, flanged ends, MSS-SP-85. Provide chain wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.6 WATER PRESSURE REDUCING VALVES

A. Watts Model 223:
   1. Up to 2 Inches (50 mm): Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, threaded ends, with strainer.
   2. Over 2 Inches (50 mm): Cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged, with strainer, MSS-SP-80.

2.7 TEMPERATURE AND PRESSURE RELIEF VALVES

A. Watts Model 40, 140, N240, 340:
   1. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

2.8 STRAINERS

A. Watts series 77:
   1. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
   2. Size 2-1/2 inch (65 mm) to 4 inch (100 mm): Flanged cast iron body, Class 125 for 200 psig (1370 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.

2.9 FLOW CONTROL VALVES

A. FDI Series ICSS.
   1. Construction: series 300 stainless steel body with nickel plated union nut.
   2. Threaded inlet and outlet connection.
   3. Automatic flow cartridge, stainless steel with machined piston, stainless steel spring, factory set calibration.
   4. Maximum operating temperature: 180 degrees F.
   5. NSF 61 certification.

B. Victaulic/TA Series 76X:
   1. Construction: series 300 stainless steel body with nickel plated union nut.
   2. Threaded inlet and outlet connection.
   3. Automatic flow cartridge, stainless steel with machined piston, stainless steel spring, factory set calibration.
   4. Maximum operating temperature: 180 degrees F.
   5. NSF 61 certification.

2.10 BALANCING VALVES

A. Bell & Gossett CB Series:
1. Construction: Brass or bronze body with union on inlet, temperature and pressure test plug on inlet and outlet.
2. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control.

2.11 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventers: ANSI/ASSE 1013, AWWA C506; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; test cocks, Watts 909 or equal.

2.12 THERMOSTATIC MIXING VALVES

A. Manufacturers: Powers model as scheduled on the drawings.

B. Other acceptable manufacturers offer equivalent products:
1. Lawler
2. Leonard
3. Symmons
4. Acorn

C. Accessories:
1. Check valves on inlets.
2. Volume control shut-off valve on outlet.
3. Stem thermometer on outlet.
4. Strainer stop checks on inlets.

D. Temp control thermostatic controller with swivel action check stops, removable cartridge with strainer, stainless steel piston and liquid filled motor with bellows mounted out of water, rough brass finish

E. Valve body: lead free bronze or brass.

F. Cabinet: 16 gage (1.5 mm) prime coated steel, for surface mounting with keyed lock.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

D. Install valves with clearance for installation of insulation and allowing access.

E. Provide access where valves and fittings are not accessible. [Coordinate size and location of access doors with Section 08 31 13.]

F. Provide water hammer arrestors on all quick closing valves including but not limited to flush valves.

G. Refer to Section [22 05 29] for pipe hangers.

H. Refer to Section [22 07 00] for insulation requirements for valves.

I. Refer to Section [22 05 03] for piping materials applying to various system types.

3.3 VALVE APPLICATIONS

A. Install [shutoff] [and] [drain] valves at locations indicated on Drawings in accordance with this Section.

B. Install [ball] valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install globe] valves for throttling, bypass, or manual flow control services.

D. Install spring loaded check valves on discharge of water pumps.

E. Install [lever and weight] [lever and spring] check valves on discharge of pumps in [pumped sanitary] piping.

F. Install lug or grooved end butterfly valves adjacent to equipment when functioning to isolate equipment.

G. Install flow control valves at the remote part of the domestic hot water return system. Valve size shall be minimum of 3/4-inch

H. Provide line sized isolation valves on all domestic water branches of ¾” or greater and when more than two fixtures are supplied.

I. Install [ball] [butterfly] [and] [gate] valves in domestic water systems for shut-off service.

END OF SECTION

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Firestopping relating to plumbing work.
9. Firestopping accessories.
10. Equipment bases and supports.

B. Related Sections:
1. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for placement of inserts sleeves in concrete forms specified by this section.
2. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
3. Section 22 04 00 – General Conditions for Plumbing Trades
4. Section 22 05 00 – Common work results for Plumbing
5. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
6. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
7. Section 22 05 23 - General-Duty Valves for Plumbing Piping
8. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
9. Section 22 05 53 – Identification for Plumbing Piping and Equipment
10. Section 22 07 00 - Plumbing Insulation
11. Section 22 15 00 – Specialty Plumbing Systems and Equipment
12. Section 22 30 00 – Plumbing Specialties
13. Section 22 34 00 – Fuel Fired Domestic Water Heaters
14. Section 22 40 00 – Plumbing Fixtures

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:
   1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
   3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:
   1. UL 263 - Fire Tests of Building Construction and Materials.
   2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
   5. UL - Fire Resistance Directory.

G. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119 ASTM E814 UL 263 UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.

B. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479, to achieve fire ratings of adjacent construction noted in Schedule at end of this section. in accordance with FM UL WH noted in Schedule at end of this section.

C. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code FM UL WH for fire resistance ratings and surface burning characteristics.

B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.6 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

E. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Submit sizing methods calculations sealed by a registered professional engineer.

F. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

H. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7 QUALITY ASSURANCE

A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
a. Floor Penetrations Within Wall Cavities: T-Rating is not required.

B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

F. Perform Work in accordance with applicable authority AWS D1.1 for welding hanger and support attachments to building structure.

G. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum years documented experience.

1.9 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas to receive solvent cured materials.

1.12 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.13 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
1. Nibco
2. Empire
3. Flex-Weld, Inc.
4. Glope Pipe Hanger Products Inc.
5. Michigan Hanger Co.
6. Superior Valve Co.
7. Substitutions: Section 01 60 00 - Product Requirements.

B. Plumbing Piping - DWV:
1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

C. Plumbing Piping - Water:
1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.

12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, Carbon-steel ring.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

A. Manufacturers:
1. Thunderline
2. Link Seal
3. Fernco
4. BWM
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:
1. Waterproofing: 5 lb./sq. ft sheet lead.
2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sealant: Acrylic; refer to Section 07 90 00.

2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation
3. Fernco
4. BWM Model
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division
4. Unistrut Corp.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Galvanized 12 gage) thick steel. With holes 1-1/2 inches on center.

2.8 FIRESTOPPING

A. Manufacturers:
1. Dow Corning Corp.
2. Fire Trak Corp.
3. Hilti Corp.
4. International Protective Coating Corp.
5. 3M fire Protection Products
6. Specified Technology, Inc.
7. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Single component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.

7. Firestop Pillows: Formed mineral fiber pillows.

C. Color:As selected from manufacturer's full range of colors.

2.9 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:
1. Mineral fiberboard.
2. Mineral fiber matting.
3. Sheet metal.
4. Plywood or particle board.
5. Alumina silicate fire board.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:
1. Furnish UL listed products or products tested by independent testing laboratory.
2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install damming materials to arrest liquid material leakage.

D. Obtain permission from Architect/Engineer before using powder-actuated anchors.

E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of recessed into and grouted flush with slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.1 ASME B31.5 ASME 31.9 ASTM F708 MSS SP 58 MSS SP 69 MSS SP 89.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.

H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for copper piping sheet lead packing between hanger or support and piping.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment Refer to Section 03 30 00.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members formed steel channel steel pipe and fittings Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 21 05 48.

3.6 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor, shower, mop sink drains watertight to adjacent materials.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping. Refer to Section 07 84 13

3.9 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
Cast Iron (All Sizes)	5	5/8
Cast Iron (All Sizes) with 10 foot length of pipe	10	5/8
Copper Tube, 1-1/4 inches and smaller	6	1/2
Copper Tube, 1-1/2 inches and larger	10	1/2
Glass	8	1/2
Polybutylene	2.67	3/8
Polypropylene	4	3/8
PVC (All Sizes)	4	3/8
Steel, 3 inches and smaller	12	1/2
Steel, 4 inches and larger	12	5/8

END OF SECTION

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 INTENT

A. All plumbing equipment and piping as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.

B. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.

C. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.

D. All such systems must be installed in strict accordance with seismic codes, component manufacturer's recommendations and building construction standards. Whenever a conflict occurs between the manufacturer's recommendations or construction standards, the most stringent shall apply.

E. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements).

F. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.2 SUMMARY

A. Section Includes:
1. Certification of seismic restraint designs and installation supervision.
2. Certification of seismic attachment of housekeeping pads.
3. NOTE: For all mechanical and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included.
4. Seismic restraint products
    a. Vibration isolation elements.
    b. Equipment isolation bases.
    c. Piping flexible connections.
    d. Seismic restraints for isolated and non-isolated mechanical and electrical items.
5. Inertia bases.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of isolators in floating floor slabs specified by this section and product requirements for concrete for placement by this section.
2. Section 07 90 00 - Joint Protection: Product requirements for joint sealers specified for placement by this section.
3. Section 23 04 00 – General Conditions for Mechanical Trades

4. Section 22 04 00 – General Conditions for Plumbing Trades
5. Section 22 05 00 – Common work results for Plumbing
6. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
7. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
8. Section 22 05 23 - General-Duty Valves for Plumbing Piping
9. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
10. Section 22 05 53 – Identification for Plumbing Piping and Equipment
11. Section 22 07 00 - Plumbing Insulation
12. Section 22 15 00 – Specialty Plumbing Systems and Equipment
13. Section 22 30 00 – Plumbing Specialties
14. Section 22 34 00 – Fuel Fired Domestic Water Heaters
15. Section 22 40 00 – Plumbing Fixtures

1.3 REFERENCES

A. American National Standards Institute:
1. ANSI S1.4 - Sound Level Meters.
2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
3. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

B. Air-Conditioning and Refrigeration Institute:
1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.

C. American Society of Heating, Refrigerating and:
1. ASHRAE Handbook - HVAC Applications.

1.4 RELATED WORK

A. Housekeeping Pads
1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel
1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.

C. Attachments
1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.5 SEISMIC FORCE LEVELS

A. Installations shall be designed to safely accept external forces determined in accordance with the International Building Code –2003, Section 1621 in any direction for all rigidly supported equipment without failure and permanent displacement of the equipment. Seismic restraints shall not short circuit vibration isolation systems or transmit objectionable vibration or noise.

1.6 PERFORMANCE REQUIREMENTS

A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping.

B. Provide minimum static deflection of isolators for equipment as follows:
   1. Basement, Under 20 hp
      a. 400 - 600 rpm: 1 inch
      b. 600 - 800 rpm: 0.5 inch
      c. 800 - 900 rpm: 0.2 inch
      d. 1100 - 1500 rpm: 0.14 inch
      e. Over 1500 rpm: 0.1 inch
   2. Basement, Over 20 hp
      a. 400 - 600 rpm: 2 inch
      b. 600 - 800 rpm: 1 inch
      c. 800 - 900 rpm: 0.5 inch
      d. 1100 - 1500 rpm: 0.2 inch
      e. Over 1500 rpm: 0.15 inch

C. Use concrete inertia bases for motors in excess of 40 hp and on base mounted pumps over 10 hp.

D. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.

E. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) Room Criteria (RC) as defined by ASHRAE Handbook., HVAC Applications, ANSI S1.8.
   1. Offices
      a. Executive: 30
      b. Conference rooms: 30
      c. Private: 35
      d. Open-plan areas: 40
      e. Computer/business machine areas: 45
      f. Public circulation: 45
   2. Schools
      a. Lecture and classrooms: 30
      b. Open-plan classrooms: 35
   3. Libraries: 35
   4. Concert Halls and Legitimate Theaters
      a. Theater: 25
      b. Stage house: 25
      c. Trap room: 25
      d. Orchestra pit: 25
      e. Rehearsal rooms: 25
      f. Teaching studios: 30

g. Practice rooms: 30
h. Ensemble rooms: 30
i. Shop: 45

5. Recording Studios
   a. Recording room: 20
   b. Sound Control room: 25
   c. Other Control rooms: 25
6. Movie Theaters: 30

1.7 DEFINITIONS

A. Life Safety Systems:
   1. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flow paths to fire protection and/or emergency lighting systems.
   2. All medical and life support systems.
   3. Fresh air relief systems on emergency control sequence including air handlers, conduit, duct, dampers, etc.

B. Positive Attachment:
   1. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, electrical conduit, bus duct, or cable trays, or any other equipment are not acceptable on this project as seismic anchor points.

C. Transverse Bracing:
   1. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

D. Longitudinal Bracing:
   1. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

E. Failure
   1. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" (3mm) and/or horizontal permanent deformation greater that 1/4" (6mm).

1.8 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings:
   1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
   2. Provide Drawings showing methods of suspension and support guides for conduit, piping and ceiling hung equipment.
   3. Record actual locations and installation of vibration isolators and seismic restraints including attachment points.

4. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
5. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
6. Drawings showing methods for isolation of conduits and pipes penetrating walls and floor slabs.
7. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, for each piece of equipment and/or pipe locations.

C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

D. Seismic Certification and Analysis:
1. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
2. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45 degrees to the weakest mode.
3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in section 1.06 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

E. Design Data: Submit calculations indicating maximum room sound levels are not exceeded. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as express in Table 34 of Chapter 47, “Sound and Vibration Control” of the 2003 ASHRAE Handbook – HVAC Applications, shall be used.

F. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers. acoustic housings meet or exceed specified sound transmission loss values.

G. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.

H. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

I. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.9 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of hangers including attachment points.

1.10 QUALITY ASSURANCE

A. Perform Work in accordance with ARI 575 ANSI S12.36.

B. Maintain one copy of each document on site.

1.11 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design application of seismic bracing under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.12 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.13 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.14 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall have the following responsibilities:
1. Determine vibration isolation and seismic restraint sizes and locations per specifications.
2. Provide and install isolation systems and seismic restraints as scheduled or specified.
3. Guarantee specified isolation system deflection.
4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
5. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
6. Substitution of "Internally Isolated" mechanical equipment in lieu of the specified isolation of this section is acceptable

1.15 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for inertia bases.

PART 2 PRODUCTS

2.1 INERTIA BASES

A. Manufacturers:
1. Mason
2. Vibration Eliminator
3. Vibro-Acoustics Ltd.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Structural Bases:
1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
2. Construction: Welded structural steel with gusset brackets, supporting equipment and motor with motor slide rails.

C. Concrete Inertia Bases:
1. Mass: Minimum of 1.5 times weight of isolated equipment.
2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, adequately reinforced, concrete filled.
3. Connecting Point: Reinforced to connect isolators and snubbers to base.
4. Concrete: Reinforced 3,000 psi concrete.

2.2 VIBRATION ISOLATORS

A. Manufacturers:
1. Mason
2. Vibration Eliminator
3. Amber Booth
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Open Spring Isolators:
1. Spring Isolators:
a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

C. Restrained Spring Isolators:
1. Spring Isolators:
a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.

4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
5. Restraint: Furnish mounting frame and limit stops.

D. Closed Spring Isolators:
1. Spring Isolators:
   a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.

E. Restrained Closed Spring Isolators:
1. Spring Isolators:
   a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.

F. Spring Hanger:
1. Spring Isolators:
   a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators rubber hanger with threaded insert.
4. Misalignment: Capable of 20 degree hanger rod misalignment.

G. Neoprene Pad Isolators:
1. Rubber or neoprene-waffle pads.
   a. 30 durometer.
   b. Minimum 1/2 inch thick.
   c. Maximum loading 40 psi.
   d. Height of ribs: not to exceed 0.7 times width.
2. Configuration: Single layer.

H. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

I. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

J. Seismic Snubbers:
1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Neoprene Elements: Replaceable, minimum of 0.75 inch thick.
3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify equipment and piping is installed before work in this section is started.

3.2 INSTALLATION

A. Install isolation for motor driven equipment.

B. Bases:
1. Set steel bases for 1 inch clearance between housekeeping pad and base.
2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.

C. Adjust equipment level.

D. Install spring hangers without binding.

E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

G. Provide pairs of horizontal limit springs on fans with more than 6.0 inch static pressure, and on hanger supported, horizontally mounted axial fans.

H. Provide resiliently mounted equipment and piping with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.

I. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector. as follows:
1. Up to 4 inch Diameter: First three points of support.
2. 5 to 8 inch Diameter: First four points of support.
3. 10 inch Diameter and Over:First six points of support.
4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect isolated equipment after installation and submit report. Include static deflections.

C. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to plumbing equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

D. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

3.4 SCHEDULES

A. Pipe Isolation Schedule:

Pipe Size Inch	Isolated Distance from Equipment
1	120 diameters
2	90 diameters
3	80 diameters
4	75 diameters
6	60 diameters
8	60 diameters
10	54 diameters
12	50 diameters
16	45 diameters
24	38 diameters
Over 24	

3.5 VIBRATION ISOLATION AND SEISMIC RESTRAINT INSTALLATION

A. Horizontal pipe isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in specification 11. Specification 11 hangers must also be used in all transverse braced isolated locations. Brace hanger rods with SRC clamps specification 14. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in specification 10. Floor supported piping shall rest on isolators as described in specification 6. Heat exchanger's and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical. Where piping connects to

mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.

B. Riser isolation: Risers shall be suspended from specification 10 hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to ± 25% of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

C. Seismic Restraint of Piping

1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables if isolated. Specification 12 or 13 restraints may be used on unisolated piping.
   a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is 1" (25mm) I.D. or larger.
   b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" (32mm) I.D. and larger.
   c. All other piping 2 1/2" (64mm) diameter and larger.
2. Transverse piping restraints shall be at 40' (12m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80' (24m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
5. For fuel oil and all gas piping transverse restraints must be at 20' (6m) maximum and longitudinal restraints at 40' (12m) maximum spacing.
6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" (600m) of the elbow or TEE or combined stresses are within allowable limits at longer distances.
7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines may not be used to restrain main lines.
9. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly in Zones 2B, 3 and 4 shall be braced as in sections 3.2.D.2 and 3. For Zones 0, 1 and 2A, 2 band clamps may be used with reduced spacings of 1/2 of those listed in sections 3.2.D.2 and 3.

D. Vibration Isolation and Seismic Restraint of Plumbing Equipment

1. All equipment shall be vibration isolated and seismically restrained as per the schedules in part 3.5 of this specification.
2. Equipment mounted on housekeeping pads: Pads shall be properly doweled or expansion shielded to deck to meet acceleration criteria.
3. Requirements for installation on concrete inertia bases shall be as follows:
   a. Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".

b. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
c. The isolators shall be installed without raising the machine and frame assembly.
d. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
e. Install equipment with flexibility in wiring connection.
f. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".
g. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators, or seismic restraints.

3.6 SEISMIC RESTRAINT EXCLUSIONS

A. General: All mechanical and electrical components and systems that are considered exempt from the requirement for seismic restraint, in accordance with The International Building Code – 2003, Section.1621 and all related State of Connecticut Supplements, shall not require seismic restraint.

B. Piping
1. Piping in boiler and mechanical rooms less than 1 1/4" (32mm) inside diameter.
2. All other piping less than 2 1/2" (64mm) inside diameter.
3. All piping suspended by individual hangers 12" (300mm) or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" (300mm) limit is exceeded by any hanger in the run, seismic bracing is required for the run.
4. The 12" (300mm) exemption applies for trapeze supported systems if the top of each item supported by the trapeze qualifies.

3.7 INSPECTION

A. Examine systems under provisions of Division 1.

B. On completion of installation of all vibration isolation devices herein specified, the local representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Sections:
1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.
2. Section 22 04 00 – General Conditions for Plumbing Trades
3. Section 22 05 00 – Common work results for Plumbing
4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
5. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
6. Section 22 05 23 - General-Duty Valves for Plumbing Piping
7. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
8. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
9. Section 22 07 00 - Plumbing Insulation
10. Section 22 15 00 – Specialty Plumbing Systems and Equipment
11. Section 22 30 00 – Plumbing Specialties
12. Section 22 34 00 – Fuel Fired Domestic Water Heaters
13. Section 22 40 00 – Plumbing Fixtures

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 QUALITY ASSURANCE

A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.

B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two containers of spray-on adhesive

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
1. Craftmark Identification Systems
2. Safety Sign Co.
3. Seton Identification Products
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

A. Plastic Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Section 01 60 00 - Product Requirements.

2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter

B. Metal Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Section 01 60 00 - Product Requirements.

2. Stainless Steel with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

C. Information Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Section 01 60 00 - Product Requirements.

2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

D. Tag Chart: Typewritten letter size list of applied tags and location plastic laminated.

2.3 STENCILS

A. Manufacturers:
1. Craftmark Identification Systems
2. Safety Sign Co.
3. Seton Identification Products
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Stencils: With clean cut symbols and letters of following size:
1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches inches high letters.
4. Ductwork and Equipment: 1-3/4 inches high letters.

C. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.4 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Section 01 60 00 - Product Requirements.

2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Section 01 60 00 - Product Requirements.

2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:
1. Manufacturers:
a. Seton
b. Northtown
c. Kolbi
d. Substitutions: Section 01 60 00 - Product Requirements.

2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.5 CEILING TACKS

A. Manufacturers:
1. Seton
2. Northtown
3. Kolbi
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Steel with 3/4 inch diameter color-coded head.

C. Color code as follows:
1. Plumbing valves: Green.

2.6 LABELS

A. Manufacturers:
1. Seton
2. Northtown

3. Kolbi
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

2.7 LOCKOUT DEVICES

A. Lockout Hasps:
1. Manufacturers:
a. Seton
b. Brady
c. Omark
d. Substitutions: Section 01 60 00 - Product Requirements
2. Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

B. Valve Lockout Devices:
1. Manufacturers:
a. Seton
b. Brady
c. Omark
d. Substitutions: Section 01 60 00 - Product Requirements.
2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION

A. Apply stencil painting in accordance with Section 09 90 00.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Install piping identification on medical gas systems. Refer to Section 22 60 13.

H. Identify water heaters, pumps, tanks, and water treatment devices with plastic nameplates stencil painting. Identify in-line pumps and other small devices with tags.

I. Identify control panels and major control components outside panels with plastic nameplates.

J. Identify valves in main and branch piping with tags.

K. Identify piping, concealed or exposed, with plastic pipe markers plastic tape pipe markers stenciled painting. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

L. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 220700 - PLUMBING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Plumbing piping insulation, jackets and accessories.
2. Plumbing equipment insulation, jackets and accessories.

B. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
3. Section 22 04 00 – General Conditions for Plumbing Trades
4. Section 22 05 00 – Common work results for Plumbing
5. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
6. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
7. Section 22 05 23 - General-Duty Valves for Plumbing Piping
8. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
9. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
10. Section 22 05 53 – Identification for Plumbing Piping and Equipment
11. Section 22 15 00 – Specialty Plumbing Systems and Equipment
12. Section 22 30 00 – Plumbing Specialties
13. Section 22 34 00 – Fuel Fired Domestic Water Heaters
14. Section 22 40 00 – Plumbing Fixtures
15. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 REFERENCES

A. ASTM International:
1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
10. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
11. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

12. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
13. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
14. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
15. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
16. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
17. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
18. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
19. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
20. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 450 50 in accordance with ASTM E84.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Maintain one copy copies of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for man made fiber.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
1. CertainTeed.
2. Knauf.
3. Johns Manville.
4. Owens-Corning.
5. Substitutions: Section 01 60 00 - Product Requirements Not Permitted.

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
1. Aeroflex. Aerocell.
2. Armacell, LLC. Armaflex.
3. Nomaco. K-flex.
4. Substitutions: Section 01 60 00 - Product Requirements.

C. Manufacturers for Polyisocyanurate Foam Insulation Products:
1. Dow Chemical Company.

2. Johns Manville.
3. Green Polyiso.
4. Substitutions: Section 01 60 00 - Product Requirements.

D. Manufacturers for Extruded Polystyrene Insulation Products:
1. Dow Chemical Company.
2. Johns Manville.
3. Substitutions: Section 01 60 00 - Product Requirements.

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:
1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Pipe Jacket:
1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 15 mil.
3. Connections: Brush on welding adhesive Tacks Pressure sensitive color matching vinyl tape.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum stainless steel jacket single piece construction with self adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 1.65 pound per cubic foot.

B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied kraft reinforced aluminum foil jacket.
1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 3.0 pound per cubic foot.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

C. TYPE E-8: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.
3. .

2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:
1. Product Description: ASTM D1785, sheet material, off-white color.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 150 degrees F.
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
5. Thickness: 20 mil.
6. Connections: Brush on welding adhesive Tacks Pressure sensitive color matching vinyl tape.

B. Aluminum Equipment Jacket:
1. ASTM B209.
2. Thickness: 0.020 inch thick sheet.
3. Finish: Smooth Embossed
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum. 0.010 inch thick stainless steel.

C. Stainless Steel Equipment Jacket:
1. ASTM ASTM A240/A240M OR ASTM 666 Type 302 304 316 stainless steel.
2. Thickness: 0.010 0.016 0.018 inch thick.
3. Finish: Smooth. Corrugated.
4. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

D. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

E. Vapor Retarder Jacket:
1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

F. Field Applied Glass Fiber Fabric Jacket System:
1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:
   a. Cloth: Untreated; 9 oz/sq yd weight.
   b. Blanket: 1.0 lb/cu ft density.
   c. Weave: 10 x 10.
3. Indoor Vapor Retarder Finish:
   a. Cloth: Untreated; 9 oz/sq yd weight.
   b. Vinyl emulsion type acrylic, compatible with insulation, black white color.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify piping and equipment has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:
1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Polyisocyanurate Foam Insulation Extruded Polystyrene Insulation:
1. Wrap elbows and fitting with vapor retarder tape.
2. Seal butt joints with vapor retarder tape.

F. Hot Piping Systems less than 140 degrees F:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

G. Hot Piping Systems greater than 140 degrees F:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

H. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
    a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

I. Insulation Terminating Points:
   1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
   2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
   3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

J. Closed Cell Elastomeric Insulation:
   1. Push insulation on to piping.
   2. Miter joints at elbows.
   3. Seal seams and butt joints with manufacturer's recommended adhesive.
   4. When application requires multiple layers, apply with joints staggered.
   5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

K. High Temperature Pipe Insulation:
   1. Install in multiple layers to meet thickness scheduled.
   2. Attach each layer with bands. Secure first layer with bands before installing next layer.
   3. Stagger joints between layers.
   4. Finish with canvas jacket sized for finish painting.
   5. Cover with aluminum jacket stainless steel jacket with seams located on bottom side of horizontal piping.

L. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting PVC jacket and fitting covers ABS jacket and fitting covers aluminum jacket stainless steel jacket.

M. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

N. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

O. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

P. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

Q. Prepare pipe insulation for finish painting. Refer to Section 09 90 00.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F Or Less:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Containing Fluids Over 140 degrees F:
1. Insulate flanges and unions with removable sections and jackets.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting PVC jacket and fitting covers aluminum jacket stainless steel jacket.

H. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum stainless steel jacket with seams located on bottom side of horizontal equipment.

I. Cover glass fiber cellular glass hydrous calcium silicate cellular foam insulation with metal mesh and finish with heavy coat of insulating cement aluminum jacket stainless steel jacket.

J. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

K. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

L. Prepare equipment insulation for finish painting. Refer to Section 09 90 00.

3.4 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Domestic Hot Water Supply and Recirculation	P-1	1-1/4 inches and smaller 1-1/2 inches and larger	0.5 1.0
Domestic Hot Water Supply and Recirculation systems with domestic water temperature maintenance cable	P-1	1 inch and smaller 1-1/4 inches to 2 inches 2-1/2 inches and larger	1.0 1.5 2.0
Domestic Cold Water	P-1 or P-5	1-1/4 inches and smaller 1-1/2 inches and larger	0.5 1.0

B. Drainage Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Storm Piping (above ground within building)	P-1 or P-5	All sizes	1.0
Storm Piping (horizontal and vertical above ground within building when PVC pipe is used)	P-1 or P-5	All sizes	1.0
Sanitary Sewer Piping (horizontal and vertical above ground within building when PVC or plastic piping is used)	P-1 or P-5	All sizes	1.0

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches
Roof Drain Bodies	E-2 E-8	0.5
Domestic Hot Water Storage Tanks	E-1 E-2	1.5
Domestic Water Storage Tanks	E-1 E-2 E-8	1.0
Domestic Water Booster Pump Bodies	E-8	0.5

END OF SECTION

SECTION 22 08 00 - COMMISSIONING OF PLUMBING

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 includes commissioning process requirements for Plumbing systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

A. Refer to Division 01 Section “General Commissioning Requirements” for the description of commissioning.

1.4 DEFINITIONS

A. Refer to Division 01 Section “General Commissioning Requirements” for definitions.

1.5 SUBMITTALS

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s role.

B. Refer to Division 01 Section “Submittals” for specific requirements. In addition, provide the following:

C. Certificates of readiness

D. Certificates of completion of installation, prestart, and startup activities.

E. O&M manuals

F. Test reports

1.6 QUALITY ASSURANCE

A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the contractor for the equipment being tested. For example, the plumbing contractor of Division 22 shall ultimately be responsible for all standard testing equipment for the plumbing system in Division 22, except for equipment specific to and used by TAB in their commissioning responsibilities.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems.

B. Red-lined Drawings: The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.

C. Operation and Maintenance Data: Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been mad by the contractor.

D. Demonstration and Training: Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior the training session

3.2 CONTRACTOR'S RESPONSIBILITIES

A. Perform tests as required by Division 22.

B. Attend construction phase controls coordination meetings as required.

C. Participate in Plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

D. Provide information requested by the CxA for final commissioning documentation.

E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.

F. Prepare preliminary schedule for Plumbing system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, testing and balancing and task completion for owner. Distribute preliminary schedule to commissioning team members.

G. Update schedule as required throughout the construction period.

H. Assist the CxA in all verification and functional performance tests.

I. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

J. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.

K. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.

L. Notify the CxA a minimum of two weeks in advance of the time for start of the balancing work..

M. Participate in, and schedule vendors and contractors to participate in the training sessions.

N. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
   1. Plumbing equipment including domestic water heaters, controls, pumps, valves plumbing fixtures, and all other equipment furnished under this Division.

O. The equipment supplier shall document the performance of his equipment.

P. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.

Q. Balance Contractor
   1. At the completion of the balancing work, and the submittal of the final balancing report, notify the Plumbing contractor and the CM/GC.

R. Equipment Suppliers
   1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
   2. Assist in equipment testing per agreements with contractors.
   3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.

S. Refer to Division 01 Section “General Commissioning Requirements” for additional contractor responsibilities.

3.3 CxA'S RESPONSIBILITIES

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s Responsibilities.

3.4 TESTING PREPARATION

A. Certify in writing to the CxA that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify in writing to the CxA that Plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify in writing that balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.5 DOMESTIC WATER BALANCING

A. Notify the CxA at least ten (10) days in advance of testing and balancing Work, and provide access for the CxA to witness balancing Work.

3.6 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of Plumbing testing shall include entire Plumbing installation. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the Plumbing contractor, balancing subcontractor shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.7 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 22 sections. Provide submittals, test data, inspector record, and certifications to the CxA.

B. Plumbing Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 22 Sections. Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment: Test requirements are specified in Division 22 piping Sections. Plumbing Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Plumbing Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of domestic water distribution systems.

E. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls as required.

F. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

Plumbing Systems
Domestic hot water heating
Water using systems

3.8 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.9 APPROVAL

A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.10 DEFERRED TESTING

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.11 OPERATION AND MAINTENANCE MANUALS

A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.

B. Refer to Division 01 Section “General Commissioning Requirements” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.12 TRAINING OF OWNER PERSONNEL

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to training.

END OF SECTION 22 08 00

SECTION 221113 – FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include complying with CTHPB standards. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling and an indoor quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental compliance goals

1.3 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service and fire service mains.

B. Comply with the Town of Rocky Hill specifications and details.

C. Comply with the Metropolitan District specifications and details.

1.4 SCOPE OF WORK

A. The Work specified in this Section includes furnishing and installing variously sized ductile iron pipe and fittings for water main to the lines and grades shown on the Contract Drawings complete as shown, specified or directed. The Work includes furnishing, installing and field testing the pipelines complete with lacings and harnessing, restraints, transporting materials, clearing, trenching, disposing of unused excavated material, gas mains or other abandoned utilities and concrete anchors, underground warning tape, backfilling trenches, furnishing material for backfilling, traffic control, temporary and permanent paved surface restoration, miscellaneous grading, temporary and permanent unpaved surface restoration and resetting miscellaneous items, removing and disposing of concrete road base, bracing, pumping and all incidental work, except as otherwise provided for.

1.5 DEFINITIONS

A. EPDM: Ethylene propylene diene terpolymer rubber.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PA: Polyamide (nylon) plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.6 SUBMITTALS

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

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
   1. Wiring Diagrams: Power, signal, and control wiring for alarms.

C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

F. Dimensions and general details for typical length of pipe.

G. Detail of joint between pipes for both push-on and restrained joints together with installation instructions.

H. Dimensions and general details for all fittings including joint details for both mechanical and restrained joints.

I. Location plan or lists showing number of pipes and fittings and other such information as needed for installation.

J. Prior to furnishing the pipe-laying schedule, test pits shall be dug where the new pipe connects to the present water mains to ascertain the location, elevation, and cross-sectional dimensions of the present mains. This information shall be forwarded to the pipe manufacturer for incorporation into the pipe-laying schedule.

K. A certified statement that inspection and all of the specified tests have been made and met shall also be submitted.

L. For insulated pipe material, Contractor to submit the manufacturer’s literature and/or shop drawings for the material proposed.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements of the Town of Rocky Hill and Metropolitan District Commission. Include tapping of water mains and backflow prevention.
   2. Comply with standards of the Town of Rocky Hill and Metropolitan District Commission Engineering Department, Water Division for potable-water-service piping, including materials, installation, testing, and disinfection.
   3. Comply with standards of the Metropolitan District Commission Engineering Department, Water Division and Town of Rocky Hill Fire Marshal for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. 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.

D. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

E. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

F. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

G. NSF Compliance:
   1. Comply with NSF 14 for plastic potable-water-service piping.
   2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
   1. Ensure that valves are dry and internally protected against rust and corrosion.
   2. Protect valves against damage to threaded ends and flange faces.
   3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, according to the following:
   1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
   2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

D. Deliver piping 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.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.9 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution 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 water-distribution service according to requirements indicated:
   1. Notify Construction Manager and Architect no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of water-distribution service without Construction Manager and Architect's written permission.

1.10 COORDINATION

A. Coordinate connection to water main with the Town of Rocky Hill and The Metropolitan District Commission.

1.11 REFERENCES

A. The following standards based on the latest edition form a part of this Specification as referenced:
   1. ANSI/AWWA C104/A21.4 - American National Standard for Cement - Mortar Lining for Ductile-Iron Pipe and Fittings for Water
   2. ANSI/AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-Inch through 48-Inch, for Water and Other Liquids
   3. ANSI/AWWA C111/A21.11 - American National Standard for Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
   4. ANSI/AWWA C151/A21.51 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids
   5. ANSI/AWWA C153/A21.53 - American National Standard for Ductile-Iron Compact Fittings, 3-Inch through 48-Inch (75 Mm Through 300 Mm), for Water and Other Liquids
   6. ANSI/AWWA C600 - AWWA Standard for Installation of Ductile Iron Water Mains and their Appurtenances
   7. DIPRA’s Installation Guide for Ductile Iron Pipe

PART 2 - PRODUCTS

2.1 MATERIALS

A. As defined by specifications and details the Metropolitan District Commission.

2.2 DUCTILE IRON PIPE

A. The ductile iron pipe shall conform to ANSI/AWWA C151/A21.51, ANSI/AWWA, C111/A21.11, ANSI/AWWA C104/A21.4 and the following additional requirements:
   1. A. All pipe for water shall be Class 54.

2. B. All pipe shall be lined with double-thickness, cement-mortar in accord with ANSI/AWWA C104/A21.4.
3. All pipe shall have push - on joints employing a single elongated grooved rubber gasket as specified in ANSI/AWWA C111/A21.11, unless otherwise specified.
4. All pipe will be coated inside and outside with an approved bituminous material in accordance with ANSI/AWWA C104/A21.4 and ANSI/AWWA C151/A21.51.
5. The grade of ductile iron shall be 60-42-10.
6. All pipe shall be marked in accord with ANSI/AWWA C151/A21.51.
7. All requirements of the American National Standards Institute Specifications will be rigidly enforced.
8. The grooved rubber gaskets and joint lubricant shall be furnished with the pipe.
9. The gasket shall be plainly identified as to pipe size and packaged in a suitable and satisfactory manner for shipment.
10. All joint accessories shall be furnished with each pipe and shall be plainly identified as to pipe size.

2.3 DUCTILE-IRON OR GRAY-IRON FITTINGS

A. The ductile iron or gray iron fittings shall conform to ANSI/AWWA C110/A21.10, ANSI/AWWA C111/A.21.11, ANSI/AWWA C104/A21.4, ANSI/AWWA C153/A21.53 and the following additional requirements:
1. All fittings shall be lined with double-thickness cement-mortar in accord with ANSI/AWWA C104/A21.4, except sleeves, caps, and plugs.
2. All fittings will be coated inside and outside with an approved bituminous material in accord with ANSI/AWWA C104/A21.4 and Section 10-9 of ANSI/AWWA C110/A21.10.
3. All fittings shall have mechanical joints as specified in ANSI/AWWA C111/A21.11.
4. All cast and ductile iron fittings shall have a pressure rating of at least 150 psi.
5. Bolt holes in the mechanical joint bells of all fittings shall straddle the vertical centerline of the fitting (laying in horizontal position).
6. All joints accessories shall be furnished with each fitting and shall be plainly identified as to size.
7. Compact ductile iron fittings that meet AWWA Specifications may be used if approved by the Engineer.

2.4 HARNESSING

A. A. Eyebolts and lacing rods shall be of A-36 steel. All components shall be hot-dipped galvanized.

2.5 MECHANICAL JOINT RESTRAINT SPECIFICATIONS

A. Restraint devices for mechanical joint fittings and appurtenances conforming to either ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53, shall conform to the following:

B. Design
1. Restraint devices for nominal pipe sizes 3 inch through 48 inch shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10.
2. The devices shall have a working pressure rating of 350 psi for 3-16 inch and 250 psi for 18-48 inch. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes.

C. Material
1. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.
2. Ductile iron gripping wedges shall be heat treated within a range of 370 to 470 BHN.
3. Three (3) test bars shall be incrementally poured per production shift as per Underwriter's Laboratory (U.L.) Specifications and ASTM A536. Testing for tensile, yield and elongation shall be done in accordance with ASTM E8.
4. Chemical and nodularity tests shall be performed as recommended by the Ductile Iron Society, on a per ladle basis.

D. Traceability
1. An identification number consisting of year, day, plant, and shift (YYDDD) (plant designation) (Shift number), shall be cast into each gland body.
2. All physical and chemical test results shall be recorded such that they can be accessed via the identification number on the casting. These Material
3. Traceability Records (MTR's) are to be made available, in hard copy, to the purchaser that requests such documentation and submits his gland body identification number.
4. Production pieces that are too small to accommodate individual numbering, such as fasteners and wedges, shall be controlled in segregate inventory until such time as all quality control tests are passed. These component parts may then be released to a general inventory for final assembly and packaging.
5. All components shall be manufactured and assembled in the United States. The purchaser shall, with reasonable notice, have the right to plant visitation at his/her expense.

E. Installation
1. Mechanical joint restraints shall require conventional tools and installation procedures per AWWA C600, while retaining full mechanical joint deflection during assembly as well as allowing joint deflection after assembly.
2. Proper actuation of the gripping wedges shall be ensured with torque limiting twist off nuts.

F. Approvals
1. Restraint devices shall be Listed by Underwriters Laboratories (3" through 24" inch size) and Approved by Factory Mutual (3" through 12" inch size).
2. Refer to Appendix B for Owner's approved materials list for mechanical joint restraints.

2.6 RESTRAINT HARNESS SYSTEM FOR DUCTILE IRON PIPE PUSH-ON BELLS

A. Ductile iron pipe bell restraint shall consist of a wedge action restraint ring on the spigot joined to a split ductile iron ring behind the bell. The restraint ring shall have individually actuated wedges that increase their resistance to pull-out as pressure or external forces increase. The restraint ring and its wedging components shall be made of a minimum grade of 65-45-12 ductile iron confirming to ASTM A536. The wedges shall be heat treated to a minimum hardness of 370 BHN. Torque limiting twist off nuts shall be used to insure proper actuation of the restraining wedges.

B. The split ring shall be made of a minimum grade of 65-45-12 ductile iron conforming to ASTM A536. The connecting tie rods that join the two rings shall be made of low alloy steel that conforms to ANSI/ AWWA C111/ A21.11 and shall have a protective coating. The assembly shall have a rated pressure, with a minimum two to one safety factor of 350 psi in sizes sixteen inch and 250 psi in the sizes eighteen inch through thirty-six inch.

C. Refer to Appendix B for Owner's approved materials list for push-on and bell joint restraints. All restraint systems shall be installed in accordance with manufacturer' specifications. Re-use of restrained MJ Fittings will not be permitted. Once a restrained MJ fitting has been installed and nuts have been torqued off, that fitting cannot be re-used, and a new fitting will be provided at no additional cost to the Owner.

2.7 POLYETHYLENE ENCASEMENT

A. Buried pipe shall be installed with polyethylene encasement where indicated on the Drawings or specified herein. Polyethylene encasement shall have a minimum thickness of 8 mils and meet or exceed the minimum standards established by AWWA C105, current edition. Acceptable manufacturers include North Town Company, AA Thread and Seal Tape, Inc, Sigma Corp. or approved equal.
   1. Polyethylene encasement shall meet minimum size requirements per table 3 of Section 2.15 of DIPRA's Installation Guide for Ductile Iron Pipe.
   2. Test results from an independent testing agency certifying that the polyethylene encasement meets all criteria established by AWWA C105, current edition, shall be submitted to the Engineer prior to approval of the polyethylene encasement for use. In general, samples shall be submitted and include test results in accordance with the AWWA standard associated with tensile strength, elongation, dielectric strength, impact resistance, and propagation tear resistance.
   3. A 2-inch wide plastic adhesive tape, such as calpico Vinyl, Polyken 900, or approved equal, shall be used for sealing seams, cuts, or tears in polyethylene encasement. Duct tape shall not be allowed.

2.8 AIR VALVE ASSEMBLY

A. All brass fittings shall be of standard design generally used by water utilities and be in accordance with ASTM B62 and ANSI/AWWA C800.

B. The corporation stops, and angle valves shall be of good, tough, composition bronze well-mixed and free from flaws and imperfections. The corporation stops shall be of a type suitable for use in ductile iron mains. The inlet end shall have an inlet taper thread type known as the "Mueller Taper Thread".

C. Corporation stop for air valves shall be rated a minimum of 250 PSI.

D. For specific size and connection details, see the Contract Drawings and the MDC Standard Details Manual.

2.9 GATE VALVE

A. The gate valve shall conform to ANSI/AWWA C500, ANSI/AWWA C509 and the following additional requirements:
   1. Valve shall be resilient sealed.
   2. Body and bonnet shall be constructed of ASTM A536 ductile iron.
   3. Wedges shall be constructed of ASTM A536 ductile iron and encapsulated with EPDM.
   4. All other materials not specified shall be as specified in ANSI/AWWA C500 and C509.
   5. Bolts and nuts for connecting O-ring seal plates and bonnet to body shall be stainless steel.
   6. Valve shall be furnished with O-ring seals utilizing two O-rings, consistent with appropriate specifications. Valve shall be capable of having O-rings replaced while the valve is under pressure.

7. Valve shall have mechanical joint ends, unless otherwise specifically indicated, which shall conform to ANSI/AWWA C111/A21.11. All joint accessories shall be furnished with each valve.
8. Valve shall be non-rising stem.
9. Direction to open (right-hand or left-hand) shall be as shown in the MDC Standard Details Manual.
10. Operating nut shall be 2" square.
11. Valve, linings, and coatings shall conform to NSF Standard 61.
12. Valve shall have a working pressure rating of 250 psi.
13. Provide all internal and external wetted parts coated with a fusion bonded epoxy in accordance with ANSI/AWWA C550.

2.10 GATE BOX

A. The gate box shall conform to the following requirements:
1. Cast iron shall conform to ASTM A-48.
2. Top section shall be of the top flange design and shall have no bead on the bottom.
3. The word "WATER" shall be cast with raised letters in the center of the cover.
4. Base section shall be of the Dwyer design which centers the operating nut for positive access to the valve.
5. For specific gate box details, see the MDC Standard Details Manual.
6. Ten (10”) inch gate box to be used for 10” gate valve and greater.

2.11 FIRE HYDRANT

A. The fire hydrant shall conform to the latest edition of ANSI/AWWA C502, ANSI/AWWA C550 and the following additional requirements:
1. Buried depths to be obtained from Contract Drawings, MDC Standard Details Manual and field verified.
2. Hydrant to be painted bright red on aboveground section with yellow bonnets.
3. Hydrant shall be compression-type with valve opening against pressure.
4. Minimum size of valve opening: 5-inch diameter.
5. Diameter and style of inlet connection: 6-inch, mechanical joint.
6. O-ring seals are required.
7. Number and size of nozzles: two 2-1/2-inch hose nozzles and one 4-1/2-inch pumper nozzle. All threads shall be National Standard Firehose Coupling Screw Threads.
8. Direction to open: counter-clockwise, open to the left.
9. Hydrant shoe will have a protective coating of an epoxy type.
10. Refer to Appendix B for Owner’s approved materials list for hydrant manufacturers.
11. All hydrants shall be self-draining.

2.12 TAPPING SLEEVE

A. The tapping sleeve shall conform to AWWA C223 and the following additional requirements:
1. All components shall conform to NSF Standard 61.
2. A test plug shall be provided on all tapping sleeves.
3. Sleeve shall be furnished with all necessary bolts, nuts, gaskets and lubricants for assembly and installation.
4. Sleeve shall be of the split bolted type with recessed flanged or mechanical joint outlets to connect to tapping gate valves.

5. Tapping sleeve shall be of Type 304 stainless steel.

2.13 TAPPING GATE VALVE

A. The tapping gate valve shall conform to ANSI/AWWA C509 and the following additional requirements:
   1. Tapping gate valve will be resilient seated type.
   2. Valve inlet shall be flanged with raised face or mechanical joint for proper alignment with the sleeve outlet.
   3. Valve outlet shall be mechanical joint, in accordance with ANSI/AWWA C111/A21.11, with all mechanical joint accessories furnished, including approved joint restraint devices.
   4. Valve shall be manufactured with oversize seat rings to permit the use of a full-size cutter (of nominal tapping gate size). Valve shall be compatible with a Mueller Model C-1 machine or other type as designated by the Owner.
   5. Bolts and nuts for connecting O-ring seals and bonnet to body shall either be copper-silicon or stainless steel.
   6. Direction to open (right-hand or left-hand) shall be as shown in the MDC Standard Details Manual.
   7. Operating nut shall be 2" square.
   8. Valve, linings, and coatings shall conform to NSF Standard 61.

2.14 WATER METERS

A. Water meters will be furnished by Metropolitan District Commission and paid for by the contractor.

2.15 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:
   1. Manufacturers: Subject to compliance with requirements approved by the Town of Rocky Hill Fire Marshall.

2.16 ALARM DEVICES

A. Subject to compliance with requirements approved by the Town of Rocky Hill Fire Marshall and The Metropolitan District Commission specifications and details.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.2 TRANSPORTING AND DISTRIBUTING PIPE

A. During loading, transporting and unloading, more than ordinary care shall be taken to prevent injury to the pipes. Such work shall be done with each section of the pipe under the full control at all times and

under no conditions shall a pipe be dropped on the ground. Pipes shall be placed on sand beds or other methods may be employed to avoid chances of the pipe being frozen to the ground surface. The ends of pipe shall be plugged or cupped to prevent entering water, materials, animals, etc.

B. In distributing the pipes in the field, as permitted, each piece shall be placed as near as possible to the point where it is to be installed and faced in the proper direction. In case any pipe should be damaged from handling or other cause and made unacceptable to the Engineer, it shall be replaced with a new pipe at no additional cost to the Owner. The Contractor is cautioned that state, city or town authorities may not permit storing pipe, etc., within street or highway limits.

C. Pipe and accessories shall be handled to ensure delivery to the trench in sound, undamaged condition, including no injury to the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor in a satisfactory manner, at no additional cost to the Owner. No other pipe or material shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Owner. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

3.3 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Piping applications, connections, and installation shall comply with specifications and details the Town of Rocky Hill Engineering Department, Water Division and Town of Rocky Hill Fire Marshal requirements (if applicable) and The Metropolitan District Commission specifications and details.

3.4 LAYING DUCTILE IRON PIPE

A. In general, trenching for the installation of the pipeline(s) shall be in accord with Section 312000 “Earth Moving”. Proper and suitable tools and appliances for safe and convenient handling and laying of pipe shall be used, and care shall be taken to prevent coating from being damaged, particularly on the inside of the pipes.

B. Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment. Water-line materials shall not be dropped or dumped into the trench. Abrasion of the pipe coating shall be avoided. Except where necessary in making connections with other lines or as authorized by the Engineer, pipe shall be laid with the bells facing in the direction of laying.

The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relayed. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by and at the Contractor's expense in a satisfactory manner in accord with the pipe manufacturer's recommendations. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.

C. Pipe work shall not be started until the following minimum equipment is available and on site:
   1. Wheel pipe cutters, hydraulic pipe cutter or a pipe saw for the sizes of pipe to be laid;
   2. Ratchet type socket wrenches for mechanical joint bolt and nuts;
   3. At least two expandable pipe stoppers of the proper size for closing the end of the piping being laid when not actually laying pipe.

D. All pipes shall be carefully examined for defects and no pipe or other casting shall be laid which is known to be defective, and should any defective pipe or other casting be discovered after being laid, it shall be removed and replaced with a sound casting at no additional cost to the Owner.

E. The pipe shall be laid upon sound soil, cut true and even, so that the barrel of the pipe will have a bearing for its full length. In the event the trench is excavated below the grade of the bottom of the pipe, the trench will be brought up to grade with gravel, pneumatically tamped, before the pipe is laid. Should rock/ledge be occasioned said materials shall be removed and the pipe shall be installed on a compacted sand bedding minimum 6" in depth from the lowest project of the pipe in accord with Section 312000 "Earthmoving".

F. The underground warning tape shall be placed approximately two (2) feet above the top of the pipe.

G. When not actually laying pipe (e.g. overnight, weekends, holidays, etc.) the open ends of the pipe shall be kept plugged with approved watertight end caps.

H. All necessary precautions shall be taken to prevent water from entering the pipe during installation of the pipeline.

I. Unless directed otherwise by the Engineer all the following criteria shall be applied:
   1. The pipeline shall be installed a minimum of four (4) feet - six (6) inches below
   2. finished grade.
   3. The pipeline shall also be installed to provide at least eighteen (18) inches of vertical clearance between the water pipe and storm drains or sanitary sewers.
   4. When vertical clearance cannot be met concrete separation shall be installed as directed by the Engineer.

J. Install polyethylene encasement around ductile iron pipe to the limits shown on the Contract Drawings, in the MDC Standard Details Manual or specified herein and in accordance with pipe manufacturer's recommendations.
   1. Polyethylene encasement shall be installed per ANSI/AWWA C105/A21.5, Method 'A' in accordance with Section 2.15 of DIPRA's Installation Guide for Ductile Iron Pipe.
   2. A fabric type or padded sling shall be used when handling polyethylene encased pipe to prevent damage to the polyethylene encasement.
   3. All seams in the polyethylene encasement shall be sealed completely with approved 2-inch wide plastic adhesive tape.

4. Extreme care shall be taken to ensure that all rips or tears in the polyethylene encasement are properly repaired with additional tape and film as described in ANSI/AWWA C105/A21.5.
5. Extreme care shall be taken with backfilling to avoid damaging the polyethylene encasement.

3.5 CUTTING PIPE

A. Whenever the pipes require cutting, an approved saw, wheel or hydraulic type cutter shall be used. This work shall be done at no additional cost to the Owner, in a manner satisfactory to the Engineer, and only experienced men shall be engaged thereon.

3.6 JOINTS

A. On pipe with rubber gasket push-on joints, the gasket shall be installed in the socket of the pipe previously laid and the gasket then lubricated. The plain end of the pipe being laid shall then be inserted and pulled or pushed to the full depth of the socket. An approved jack-type tool shall be used to assemble pipe 10-inches and larger. Plain ends of cut pipe shall be filed or ground to a taper to prevent damage to the gasket during the insertion.

B. On fittings, butterfly and gate valves with mechanical joints, the follower ring and rubber gasket shall be placed on the plain end of the pipe being (or previously) laid and entered into the socket of the fitting. The gasket shall then be evenly seated in the socket, the follower ring moved up to the face of the gasket and the "T" bolts inserted and made finger-tight. The "T" bolts shall then be tightened with a ratchet or torque wrench as indicated in the manufacturer's instructions for installing the restrain system.

C. All mechanical joint style restrained joint fittings shall be installed in accordance with manufacturer recommendations, and as described below:
   1. Where shown on the Contract Drawings, Contractor shall conduct test pits on existing fittings to confirm presence of joint restraint. Contractor shall also retorque all bolts on existing fittings to confirm proper restraint.
   2. Mechanical or pneumatic methods cannot be used to torque off nuts (where applicable). All twist-off nuts shall be hand tightened using a clockwise only turning socket wrench.
   3. Restrained joint fittings cannot be backfilled until inspection by Owner.
   4. Contractor shall collect all torqued nuts from restrained joint installations. Owner reserves the right to request Contractor to provide torqued nuts for proof of proper installation.
   5. Where shown on the Contract Drawings, Contractor shall coordinate with Owner to shut down existing main during tie-in work. A minimum of 14-day notice shall be provided to Engineer in advance of this work.

D. The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

3.7 THRUST RESTRAINT

A. Plugs, caps, tees, reducers and bends deflecting more than the allowable deflection as given in AWWA C600, either vertically or horizontally, on waterlines 4 inches in diameter or larger, and fire hydrant laterals, shall be provided with thrust restraints. Valves shall be securely anchored or shall be provided

with thrust restraints to prevent movement. Thrust restraints shall be either restrained joints for ductile iron pipes or thrust blocks as detailed in the MDC Standard Details Manual or directed by the Engineer.

B. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2,000 psi after 28 days. Blocking shall be placed between solid ground and the hydrant or fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks. Where any section of a water line is provided with concrete thrust blocking for fittings or hydrants, the hydrostatic tests shall not be made until at least 7 days after installation of the concrete thrust blocking and providing that the concrete thrust blocking had a minimum compressive strength of not less than 2,000 psi after 7 days or unless otherwise approved by the Engineer.

C. The harnessing system for push-on joint pipe and mechanical joints shall be installed in full accord with the recommendations of the manufacturers and as approved by the Engineer.

3.8 AIR VALVES

A. The air valves, chlorination valve and blow-off shall be installed according to the details shown in the MDC Standard Details Manual and to the satisfaction of the Engineer. To properly receive the air valve or other assembly the ductile iron pipe shall be drilled and tapped. All tapped holes for corporation stops shall be “Mueller Taper Thread”.

B. All tapped holes in ductile iron pipe shall be cleaned by running the correct size tap into the hole immediately prior to installing the corporation.

C. Gate boxes shall be set plumb and centered on the fitting, etc. Earth fill shall be carefully tamped around the gate box to a distance of 4 feet on all sides of the box or to the undisturbed trench face, if less than 4 feet.

D. Excavation and refill shall conform to the requirements under other applicable Contract Sections.

3.9 INSTALLATION OF GATE VALVE, GATE BOX AND JOINT RESTRAINTS

A. The gate valve shall be installed according to the details shown in the MDC Standard Details Manual and to the satisfaction of the Engineer.

B. All debris and foreign material shall be cleared from valve openings and seats. All mechanisms shall be checked, and all nuts and bolts checked for tightness.

C. The gate box shall be set plumb and centered directly over the operating nut of the valves. Earth fill shall be carefully tamped around the gate box to a distance of 4 feet on all sides of the box or to the undisturbed trench face, if less than 4 feet.

D. Where and as shown on the Contract Drawings, or ordered, a valve extension stem shall be installed. An extension stem will be ordered when the valve-operating nut is more than 4.5’ feet below finished grade.

E. Excavation, shoring, dewatering, and refill and traffic control shall conform to the requirements under other applicable Contract Sections.

3.10 INSTALLATION OF TAPPING SLEEVE AND TAPPING GATE VALVE

A. Prior to the installation of the tapping sleeve/Tapping Gate Valve assembly, the Contractor shall excavate a test pit at the proposed tapping sleeve/tapping gate valve location, so as to determine the suitability` of said location for mounting the tapping sleeve. All the necessary permits shall have been secured prior to the start of such excavation. In the event the proposed tapping sleeve location is determined to be unsuitable by the Engineer, the Engineer shall direct the Contractor to dig another test pit or expand the original test pit so as to find a suitable location to mount said tapping sleeve. The tapping sleeve and tapping gate valve shall be installed according to the details shown in the MDC Standard Details Manual and to the satisfaction of the Engineer.

B. The tapping sleeve location on the pipe shall be carefully cleaned and inspected prior to installing the sleeve. Both the sleeve and valve shall be carefully installed and supported in position free from distortion and/or strain, by the Contractor's forces. The excavation for said assembly shall be properly supported and dewatered, all in accordance with OSHA requirements.

C. All debris and foreign material shall be cleaned from sleeve and valve openings and seats. The tapping sleeve shall be installed with the test plug on top. All mechanisms shall be checked, and all nuts and bolts checked for tightness. The Contractor shall construct a poured concrete thrust block on the backside of the tapping sleeve in accordance with the details as shown in the MDC Standard Details Manual. A minimum of 7 feet of excavation beyond the tapping gate valve shall be provided for the Owner's tapping equipment.

D. Subsequent to tapping the main (performed by the Owner), the gate box shall be set plumb and centered directly over the operating nut of the valve. Earth fill shall be carefully tamped around the gate box to a distance of 4 feet on all sides of the box or to the undisturbed trench face, if less than 4 feet.

E. Where and as shown on the Contract Drawings, or ordered, valve extension stems shall be installed. An extension stem will be ordered when the valve-operating nut is more than 4.5 feet below finished grade.

F. Excavation and refill shall conform to the requirements under other applicable Contract Sections. Temporary and permanent paved and unpaved surface restoration shall conform with the requirements under other applicable Contract Sections.

3.11 TAPPING EXISTING WATER MAIN - (For tapping size of 12-inches or less)

A. At least ten (10) working days prior to the scheduled tapping date, the Systems Repair Department of the Operations Division of the Metropolitan District shall be contacted at telephone 278-7850 extension 3629 or 3627 to confirm the scheduled date. Owner forces will install the tapping machine and perform all tapping operations on the existing water main. If in the opinion of the Engineer the excavation support is not safe for the Owner to execute the tapping, the Owner will not execute the tap. The Contractor will be responsible to reinstall the trench support and reschedule the tapping date. The Owner will back charge the Contractor for its down time (labor and equipment) related to mobilization and demobilization related to this tap

3.12 VALVE APPLICATIONS

A. Valve applications, connections, and installation shall comply with specifications and details the Town of Rocky Hill Engineering Department, Water Division and Town of Rocky Hill Fire Marshal requirements (if applicable) and The Metropolitan District Commission specifications and details.

3.13 CLEANING MDC WATER MAINS

A. Before, and after, if required, the installation of the pipeline, but prior to filling the line with water, the interior of the pipelines shall be cleaned to the satisfaction of the Engineer, by such means as the Engineer approves.

3.14 FIELD TESTING

A. Prior to disinfection, the pipeline shall be tested for leakage between test bulkheads and/or main line valves. The pipeline will be filled with water and tested in accord with the latest ANSI/AWWA C600 under a pressure of 150 psi at the lowest point in the pipeline. Under the test pressure, all visible leaks shall be made tight to the satisfaction of the Engineer. The total leakage per 24 hours from the line thus tested shall not exceed the allowed leakage as determined by the Engineer based on the latest ANSI/AWWA C600. Visible leaks shall be repaired even though the total leakage of the portion in question may be less than the above-mentioned permissible limit. Test pressure shall be applied for at least two hours and as much longer as required to permit inspection for leaks. Should the leakage exceed the maximum specified amount and investigation show this leakage to be at the joints or caused by defective work elsewhere, such defective work shall be repaired to the satisfaction of the Engineer or, if he so orders, the pipe or pipes shall be replaced at no additional cost to the Owner and repairs or replacement shall be continued and the test repeated until the leakage under the test pressure is within the limit prescribed and the work left in a manner entirely satisfactory to the Engineer.

B. The Contractor shall be responsible for any damage to the pipeline or to adjoining property due to the testing.

3.15 INSTALLATION OF HYDRANT ASSEMBLY

A. Fire hydrants, piping, gate valves, etc. shall be installed according to the details shown in the MDC Standard Details Manual and to the satisfaction of the Engineer.

B. All debris and foreign material shall be cleared from hydrants and valve openings and seats. All mechanisms shall be checked and all nuts and bolts checked for tightness.

C. The hydrant shall be set plumb. Earth fill shall be carefully tamped around the hydrant to a distance of 4 feet on all sides of the hydrant, or to the undisturbed trench face, if less than 4 feet. Connecting pipe shall have at least the same depth of cover as the distributing main. See the MDC Standard Details Manual.

D. Not less than 12 cubic feet of broken stone shall be placed around the base of the hydrants at the location of the drain holes. Backfill around the hydrants shall be properly compacted to the grade line. Hydrants shall have the interiors cleaned of all foreign matter before installation, and shall be inspected in the open and closed positions.

E. The body of the hydrant shall be of sufficient length to allow the hydrant to be set at the proper elevation. Offset hydrant lateral to install at same depth of cover at the distributing main. Furnish and install extensions when required for greater depths. Extensions should only be used if an offset is not possible and shall be approved by Owner.

F. The underground warning tape shall be placed approximately two (2) feet above the top of the pipe.

G. Crushed stone and concrete shall be placed in accordance with Sections 312000 “Earth Moving” and 033053 “Miscellaneous Cast-In-Place Concrete” respectively.

H. Excavation and refill shall conform to the requirements under other applicable Contract Sections.

I. Final connection to hydrant shall be mega lug restrained fittings.

3.16 JOINT CONSTRUCTION

A. See Division 15 for basic piping joint construction.

B. Joint applications, connections, and installation shall comply with specifications and details the Town of Rocky Hill Engineering Department and Town of Rocky Hill Fire Marshal requirements (if applicable) and The Metropolitan District Commission specifications and details.

3.17 ANCHORAGE INSTALLATION

A. Anchorage installation shall comply with specifications and details the Town of Rocky Hill Engineering Department and Town of Rocky Hill Fire Marshal requirements (if applicable) and The Metropolitan District Commission specifications and details.

3.18 DETECTOR-CHECK VALVE INSTALLATION

A. Joint applications, connections, and installation shall comply with specifications and details the Town of Rocky Hill Engineering Department and Town of Rocky Hill Fire Marshal requirements (if applicable) and The Metropolitan District Commission specifications and details.

3.19 WATER METER INSTALLATION

A. Water Meter installation shall comply with specifications and details the Town of Rocky Hill Engineering Department and Town of Rocky Hill Fire Marshal requirements (if applicable) and The Metropolitan District Commission specifications and details.

3.20 BACKFLOW PREVENTER INSTALLATION

A. Backflow preventer installation shall comply with specifications and details the Town of Rocky Hill Engineering Department and Town of Rocky Hill Fire Marshal requirements (if applicable) and The Metropolitan District Commission specifications and details.

3.21 WATER METER BOX AND CONCRETE VAULT INSTALLATION

A. Water Meter box and concrete vault installation shall comply with specifications and details the Town of Rocky Hill Engineering Department and Town of Rocky Hill Fire Marshal requirements (if applicable) and The Metropolitan District Commission specifications and details.

3.22 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Fire department connection installation shall comply with specifications and details the Town of Rocky Hill Engineering Department and Town of Rocky Hill Fire Marshal requirements and The Metropolitan District Commission specifications and details.

3.23 FIRE HYDRANTS

A. Fire Hydrant installation shall comply with specifications and details the Town of Rocky Hill Engineering Department and Town of Rocky Hill Fire Marshal requirements (if applicable) and The Metropolitan District Commission specifications and details.

3.24 CONNECTIONS

A. Piping installation requirements are specified in other Division 22/23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. See Division 22/23 for piping connections to valves and equipment.

C. Connect water-distribution piping to utility water main. Use the Town of Rocky Hill Engineering Department and The Metropolitan District Commission, approved connection method.

D. Connect water-distribution piping to interior domestic water and fire-suppression piping.

E. Ground equipment according to Division 26 for Electrical Systems.

F. Connect wiring according to Division 26.

3.25 FIELD QUALITY CONTROL

A. Notify the Town of Rocky Hill Engineering Department and Town of Rocky Hill Fire Marshal and The Metropolitan District Commission.

B. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

C. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours or as required by Water Division.
   1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1

more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

D. Prepare reports of testing activities.

3.26 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Division 22/23 for identifying devices.

3.27 CLEANING

A. Clean and disinfect water-distribution piping as required by the Town of Rocky Hill Engineering Department and The Metropolitan District Commission.

B. Prepare reports of purging and disinfecting activities.

3.28 AS-BUILT

A. Final As-built of all items location and elevations prepared by a CT Licensed Land Surveyor in paper, Mylar and AutoCad format signed and sealed accuracy class A-2/T-2 for owner and engineer.

B. Final As-built of all items location and elevations .dwg file in AutoCAD Civil 3D format of as built prepared by a CT Licensed Land Surveyor with Civil 3D pipe networks.

END OF SECTION 22 11 13

SECTION 221123 - FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

A. Section Includes:
1. Natural gas piping buried within 5 feet of building.
2. Natural gas piping above grade.
3. Unions and flanges.
4. Valves.
5. Pipe hangers and supports.
6. Strainers.
7. Natural gas pressure regulators.
8. Natural gas pressure relief valves.
9. Underground pipe markers.
10. Bedding and cover materials.

B. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 - Access Doors and Frames
3. Section 09 90 00 - Painting and Coating
4. Section 22 04 00 – General Conditions for Plumbing Trades
5. Section 22 05 00 – Common work results for Plumbing
6. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
7. Section 22 05 23 - General-Duty Valves for Plumbing Piping
8. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
9. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
10. Section 22 05 53 – Identification for Plumbing Piping and Equipment
11. Section 22 07 00 - Plumbing Insulation
12. Section 22 15 00 – Specialty Plumbing Systems and Equipment
13. Section 22 30 00 – Plumbing Specialties
14. Section 22 34 00 – Fuel Fired Domestic Water Heaters
15. Section 22 40 00 – Plumbing Fixtures

1.3 REFERENCES

A. American National Standards Institute:
1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

B. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.

3. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
4. ASME B31.9 - Building Services Piping.
5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

E. American Water Works Association:
1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 67 - Butterfly Valves.
3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
5. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

G. National Fire Protection Association:
1. NFPA 54 - National Fuel Gas Code.

H. Underwriters Laboratories Inc.:
1. UL 842 - Valves for Flammable Fluids.

1.4 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.

C. Provide pipe hangers and supports in accordance with ASME B31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.

D. Use plug, valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
   a. Strainers.
   b. Natural gas pressure regulators.
   c. Natural gas pressure relief valves.

C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Test Reports: Indicate results of piping system pressure test.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements

F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves piping system, and system components.

C. Operation and Maintenance Data: Submit for valves and gas pressure regulators installation instructions, spare parts lists, and exploded assembly views.

1.7 QUALITY ASSURANCE

A. Perform natural gas Work in accordance with NFPA 54.

B. Perform work in accordance with NFPA 54, Fuel Gas Code and local gas company requirements.

C. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

D. Perform Work in accordance with applicable code authority having jurisdiction AWS D1.1 for welding hanger and support attachments to building structure.

E. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.

F. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design piping system hangers and supports under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location

1.9 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Do not install underground piping when bedding is wet or frozen.

1.12 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.13 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

1.14 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for valves excluding packing.

1.15 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two packing kits for each type and size valve.

PART 2 PRODUCTS

2.1 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   1. Fittings: ASTM A234/A234M forged steel welding type.
   2. Joints: ASME B31.9, welded.
   3. Jacket: AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.2 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
   2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

2.3 NATURAL GAS EQUIPMENT PIPING CONNECTION, ABOVE GRADE

A. Corrugated Stainless Steel Tubing: ANSI LC 1.

2.4 REGULATOR VENT PIPING, ABOVE GRADE

A. Indoors: Same as natural gas piping, above grade.

2.5 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
   1. Ferrous Piping: Class 150, malleable iron, threaded.
   2. Copper Piping: Class 150, bronze unions with soldered brazed joints.
   3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:
   1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
   2. Copper Piping: Class 150, slip-on bronze flanges.
   3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.6 PLUG VALVES

A. Manufacturers:
   1. DeZURIK, Unit of SPX Corp.
   2. Flow Control Equipment, Inc.
   3. Homestead Valve
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. 2 inches and Smaller: MSS SP 78, Class 300, semi-steel construction, round port, full pipe area, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.

C. 2-1/2 inches and Larger: MSS SP 78, Class 300, semi-steel construction, round port, full pipe area, pressure lubricated, teflon packing, flanged ends. Furnish wrench-operated.

2.7 EMERGENCY GAS SOLENOID VALVE

A. Manufacturers:
1. Asco.
2. DeZURIK, Unit of SPX Corp.
3. Tufline.

B. Die-cast aluminum body, Buna “N: seals and discs, 430F stainless steel core and plugnut, 305 stainless steel core tube, 320 stainless steel springs, copper shading coil, zinc plated steel plugs and threaded ends.

C. Operator: Solenoid enclosure, red hat metal type 1 general purpose junction box.

D. Zero differential, internal pilot-operated diaphragm valve incorporating a double disc arrangement.

E. Electrical: Standard coil 120 volts, 60 Hz.

F. Gas valve shall be provided as a normally closed, power open type valve.

2.8 STRAINERS

A. Manufacturers:
1. Mueller Steam Specialty
2. Armstrong
3. Spirax Sarco, Inc.
4. Yarway
5. Substitutions: Section 01 60 00 - Product Requirements.

B. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.9 NATURAL GAS PRESSURE REGULATORS

A. Manufacturers:
1. Invensys
2. Maxitrol
3. Dormont
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
1. Comply with ANSI Z21.80.
2. Temperatures: minus 20 degrees F to 150 degrees F.
3. Body: Steel.

4. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
5. Disk, diaphragm, and O-ring: Nitrile
6. Maximum inlet pressure: 150 psig.
7. Furnish sizes 2 inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

2.10 NATURAL GAS PRESSURE RELIEF VALVES

A. Manufacturers:
1. Dresser
2. Fisher
3. Maxitrol
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Spring loaded type relief valve.
1. Body: Aluminum.
2. Diaphragm: Nitrile
3. Orifice: Stainless steel.
4. Maximum operating temperature: 150 degrees F.
5. Inlet Connections: Threaded.
6. Outlet or Vent Connection: Same size as inlet connection.

PART 3 EXECUTION

3.1 EXAMINATION

A. 01300 - Administrative Requirements: Coordination and project conditions.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install hangers and supports in accordance with ASME B31.9 ASTM F708 and MSS SP 89.

B. Support horizontal piping hangers as scheduled.

C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

H. Provide copper plated hangers and supports for copper piping sheet lead packing between hanger or support and piping.

I. Prime coat exposed steel hangers and supports in accordance with Section 09 90 00. Finish paint exposed steel hangers and supports in accordance with Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.5 INSTALLATION - BURIED PIPING SYSTEMS

A. Install natural gas piping in accordance with NFPA 54.

B. Remove scale and dirt on inside of piping before assembly.

C. Excavate pipe trench in accordance with Section 31 23 16 31 23 17

D. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.

E. Install pipe on prepared bedding.

F. Route pipe in straight line.

G. Install pipe to allow for expansion and contraction without stressing pipe or joints.

H. Install plastic ribbon tape continuous. buried 6 inches below finish grade, above pipe line; coordinate with Section 31 23 23, 31 23 17

I. Pipe Cover and Backfilling:
   1. Backfill trench in accordance with Section 31 23 23
   2. Maintain optimum moisture content of fill material to attain required compaction density.
   3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 12 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
   4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
   5. Do not use wheeled or tracked vehicles for tamping.

3.6 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Install natural gas piping in accordance with NFPA 54.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient.

D. Where required, bend pipe with pipe bending tools in accordance with procedures intended for that purpose.

E. Install piping to conserve building space and not interfere with use of space.

F. Size and install gas piping to provide sufficient gas to supply maximum appliance demand at pressure higher than appliance minimum inlet pressure.

G. Group piping whenever practical at common elevations.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.

J. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 07 84 00 23 05 29

K. Provide clearance for installation of insulation and access to valves and fittings.

L. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13.

M. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer. Refer to Section 05 12 00, 05 21 00.

N. Provide support for utility meters in accordance with requirements of utility company.

O. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood. Protect vent against entry of insects and foreign material.
   1. Minimum Vent Size: Connection size at regulator vent connection.
   2. Run individual vent line from each relief device, independent of breather vents.

P. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 09 90 00.

Q. Install identification on piping systems including underground piping. Refer to Section 22 05 53.

R. Install valves with stems upright or horizontal, not inverted.

S. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

T. Install medium pressure gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.

U. Install medium pressure gas pressure regulator with tee fitting not less than 10 pipe diameters down stream of regulator. Cap or plug one opening of tee fitting.

V. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors as indicated on Drawings.

W. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 2 psi. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment. Provide source valve to shut down entire service at meter assembly.

X. Terminate pressure regulator relief vent lines as required by the utility provider.

Y. Gas solenoid valves shall be installed within 12”x12”x6” deep lockable steel enclosure.

3.7 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Where gas appliance will be damaged by test pressure, disconnect appliance and cap piping during pressure test. Reconnect appliance after pressure test and leak test connection.

C. Where gas appliance is designed for operating pressures equal to or greater than piping test pressure, provide gas valve to isolate appliance or equipment from gas test pressure.

D. Pressure test natural gas piping in accordance with NFPA 54.

E. Inspect, test and purge gas piping in accordance with applicable code and local gas company requirements. Where new branch piping is extended from existing system, pressure test new branch piping only. Leak test joint between new and existing piping with noncorrosive leak detection fluid or other approved method.

F. When pressure tests do not meet specified requirements, remove defective work, replace and retest.

G. Immediately after gas is applied to a new system, or a system has been restored after gas service interruption, check pipe for leakage.
   1. Where leakage is detected, shut off gas supply until necessary repairs are complete.

H. Do not place appliances in service until leak testing and repairs are complete.

END OF SECTION

SECTION 221313 – FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."

B. GREEN BUILDING REQUIREMENTS - The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include complying with CTHPB standards. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling and an indoor quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental compliance goals

1.2 SUMMARY

A. This Section includes sanitary sewerage outside the building.

B. Section Includes:
1. Pipe and fittings.
2. Nonpressure and pressure couplings.
3. Expansion joints and deflection fittings.
4. Backwater valves.
5. Cleanouts.
6. Encasement for piping.
7. Manholes.

C. Comply with the Town of Rocky Hill specifications and details.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

B. DIP: Ductile Iron pipe.

C. SAN MH: Concrete Sanitary Sewer Manhole

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Non-Pressure-Piping Pressure Ratings: At least equal to system test pressure.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. PVC – Sewer Pipe and Fittings.
   2. DIP – Sewer Pipe.
   3. Expansion joints and deflection fittings.
   4. Backwater valves.

B. Shop Drawings: Include plans, elevations, details, and attachments for the following:
   1. Precast concrete manholes, including frames and covers.
   2. Grease Trap size as indicated on the drawings
   3. Cleanout
   4. Extendable Backwater valve, if applicable.

C. Coordination Drawings if required: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.

D. Coordination Profile Drawings if required: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1-inch equals 50 feet (1:500) and vertical scale of not less than 1-inch equals 5 feet (1:50). Indicate underground structures and pipe. Show types, sizes, materials, and elevations of other utilities crossing system piping.

E. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations on site prior construction.

B. Locate existing structures and piping, remove as indicated on the demolition drawing or to be closed and abandoned in-place.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Construction Manager and Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Construction Manager and Architect's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

2.2 PIPES AND FITTINGS

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. PVC Sewer Pipe and Fittings: According to the following:
1. PVC Sewer Pipe and Fittings, NPS 15 (DN375) and Smaller: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.
2. Gaskets: ASTM F 477, elastomeric seals.

C. Ductile-Iron, Gravity Sewer Pipe, and Fittings
1. Pipe: ASTM A 746, for push-on joints
2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
3. Compact Fittings: AWWA C153, ductile iron, for push-on joints.
4. Gaskets: AWWA C111, rubber.

D. PVC Pressure Piping:
Pipe: AWWA C900, Class 100 or Class 150 and Class 200 PVC pipe with bell-and-spigot ends for gasketed joints.
Fittings: AWWA C900, Class 100 or Class 150 and Class 200 PVC pipe with bell ends.
Gaskets: ASTM F 477, elastomeric seals.

E. PVC Water-Service Piping:
1. Pipe: ASTM D 1785, Schedule 40, and Schedule 80 PVC, with plain ends for solvent-cemented joints.
2. Fittings: ASTM D 2466, Schedule 40 and ASTM D 2467, Schedule 80 PVC, socket type.
3. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794, open and closed profile, bell and spigot for gasketed joints.
4. Gaskets: ASTM F 477, elastomeric seals.
5. Iron Ductile pipe.
6. PVC Extendable backwater valve. Install according to manufacturer’s written instructions at www.cleancheck.com.

2.3 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
   2. For Concrete Pipes: ASTM C 443, rubber.
   3. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   4. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   5. For Dissimilar Pipes: ASTM D 5926, PVC, or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
   1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

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

E. Ring-Type, Flexible Couplings:
   1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

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

2.4 PRESSURE-TYPE PIPE COUPLINGS

A. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

B. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig or 200-psig minimum pressure rating and ends of same sizes as piping to be joined.

C. Center-Sleeve Material: Manufacturer's standard

D. Gasket Material: Natural or synthetic rubber.

E. Metal Component Finish: Corrosion-resistant coating or material.

2.5 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

   1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more

gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Expansion Joints:
   1. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for expansion indicated.

C. Ductile-Iron Deflection Fittings:
   1. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for up to 15 degrees of deflection.

2.6 BACKWATER VALVES

A. Cast-Iron Backwater Valves:
   1. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
   2. Horizontal type; with swing check valve and hub-and-spigot ends.
   3. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
   4. Terminal type; with bronze seat, swing check valve, and hub inlet.

A. PVC Backwater Valves:
   5. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

2.7 SEWER MAINS PIPE, FITTINGS, AND SPECIALS

A. The polyvinyl chloride pipe and fittings, including also those required for stubs, shall conform to one of the following:
   1. ASTM D3034 for diameters 6-inch through 15-inch,
   2. ASTM F679 (Wall thickness T- 1) for diameters 18-inch through 27-inch,
   3. ASTM F949 for 6 to 36-inch diameter polyvinyl chloride (PVC) pipe with a smooth interior.
   4. Closed profile pipe conforming to ASTM F1803 for diameters 18-inches through 48-inches.
   5. ASTM F794 for diameters 18-inches through 48-inches.

B. The pipe shall have pipe diameter to wall thickness ratio (SDR) of a maximum of 35, unless otherwise indicated and/or approved by the Engineer. Refer to Appendix B for the Owner's approved materials list. Closed profile pipe shall have a minimum stiffness of 46 psi for 18 inch to 27-inch PVC sewer pipe and minimum stiffness of 50 psi for 30-inch and larger diameter PVC pipe.

C. Straight pipe shall be furnished in lengths of not more than 13 feet, and Y-branches shall be furnished in lengths of not more than 3 feet, unless otherwise permitted by the Engineer. Saddle Y-branches will not be allowed.

D. Fittings and special pipe pieces (specials) shall conform to the specifications for straight pipe insofar as applicable and to the details indicated in the MDC Standard Details Manual.

E. Foundation, base, haunching, backfill and bedding shall be as shown in the MDC Standard Details Manual and as specified in Sections 312000 "Earth Moving".

F. Geotextile fabric shall have an effective opening size of 70 µm.

G. PVC hub, stainless steel band, and rubber sleeve shall be used for drain service lateral connections to mainline pipe and shall be as manufactured by Inserta Tee or equal.

2.8 JOINTS

A. Joints for the polyvinyl chloride pipe shall be push-on bell and spigot joints using elastomeric ring gaskets conforming to ASTM F477. The gaskets shall be securely fixed into place in the bells so that they cannot be dislodged during joint assembly. The gaskets shall be of a composition and texture which is resistant to common ingredients of sewage and industrial wastes, including oils and groundwater, and which will endure permanently under the conditions of the proposed use. The joints shall conform to ASTM D3212.

2.9 CLEANOUTS

A. Cast-Iron Cleanouts:
1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:
1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to clean-out of same material as sewer piping.

2.10 BEDDING AND BACKFILL MATERIAL

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. The material shall be sand or sandy soil, all of which passes a 3/8-inch sieve, and not more than 10% passes a No.200 sieve.

C. When ground water is encountered, the bedding may be ¾” crushed stone conforming to the requirements of Section M.01.01 for No.6 stone of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 816, including current supplemental.

2.11 GEOTETILE FABRIC

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
1. Grab Tensile Strength: 110 lbf (490 N); ASTM D 4632.
2. Tear Strength: 40 lbf (178 N); ASTM D 4533.

3. Puncture Resistance: 50 lbf (222 N); ASTM D 4833.
4. Water Flow Rate: 150 gpm per sq. ft. (100 L/s per sq. m); ASTM D 4491.
5. Apparent Opening Size: No. 50 (0.3 mm); ASTM D 4751.

2.12 GREASE TRAP

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. Heavy Duty-Traffic Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.

C. Requirements to meet the current CT Public Health Code, CT DEEP General Permit and the Town of Rocky Hill Engineering Department requirements and standards.
1. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
2. Epoxy coated inside
3. H-20 loading

D. Outdoor In-Ground Grease Trap/Interceptor:
1. The grease trap/interceptor shall be installed on a separate building sewer line servicing kitchen flows and shall be connected to those fixtures or drains which would allow fats, oils, and grease to be discharged. This shall include:
   a. pot sinks;
   b. pre-rinse sinks;
   c. any sink into which fats, oils, or grease are likely to be introduced;
   d. soup kettles or similar devices;
   e. wok stations;
   f. floor drains or sinks into which kettles may be drained;
   g. automatic hood wash units;
   h. dishwashers without pre-rinse sinks; and
   i. any other fixtures or drains that are likely to allow fats, oils, and grease to be discharged.

2. An outdoor, in-ground grease trap/interceptor shall have a minimum depth of four (4) feet and a minimum volume of:
   a. The volume equivalent to the maximum daily flow over a twenty-four (24) hour period from all fixtures connected to the grease trap/ interceptor based on water meter records or other methods of calculation as approved by the authorized agent, or
   b. 1000 gallons, whichever is greater.

3. The grease trap/interceptor shall be watertight and constructed of concrete or other durable material. It shall be located so as to be accessible for convenient inspection and maintenance. No permanent or temporary structures or containers shall be placed directly over the grease trap/interceptor. Grease trap/interceptors installed in areas subject to traffic shall be designed to accommodate traffic loading.

4. If the grease trap/interceptor is constructed of concrete the following requirements shall apply:
   a. All concrete grease trap/interceptors shall be produced with minimum 4,000-psi concrete per ASTM standards with four (4) to seven (7) percent air entrainment.
   b. The minimum liquid depth of the grease trap/interceptor shall be thirty-six (36) inches, measured from the bottom of the tank to the outlet invert.

c. The air space provided between the liquid height and the underside of the tank top shall be a minimum of eight (8) inches.
d. All structural seams and/or lifting holes shall be grouted with non-shrinking cement or similar material and coated with a waterproof sealant. In areas where seasonal high ground water is at an elevation greater than the bottom of the grease trap/interceptor, but below the top of the grease trap/interceptor, the exterior of the grease trap/interceptor including the exterior top, sides and bottom shall be coated with a waterproof sealant creating a water tight condition for the tank. In areas where seasonal high ground water is at an elevation greater than the top of the grease trap/interceptor, the exterior of the manhole extensions to grade shall be coated with a waterproof sealant creating a watertight condition for the extension.
e. The invert elevation of the inlet shall be between three (3) inches and six (6) inches above the invert elevation of the outlet.

5. All non-concrete tanks shall meet the requirements set forth in Sections 5(b)(1)(C) and 5(b)(1)(D)(ii), (iii), and (v) of the general permit.
6. Separate cleanout covers shall be provided over the inlet and outlet of the grease trap/interceptor so as to provide easy access for inspection and cleaning. Cleanout ports shall be fitted with manhole extensions to grade. In areas subject to traffic, the extensions shall be constructed of a material sufficient to withstand the traffic load. Where concrete covers are used, the lid must either weigh a minimum of fifty-nine (59) pounds or contain a locking mechanism to prevent unauthorized entrance. The manholes, extensions, and inlet and outlet access holes to the grease trap/interceptor shall have a minimum inside diameter of seventeen (17) inches.

7. The inlet and outlet piping shall be PVC ASTM D 1785 Schedule 40 with rubber compression gaskets or solvent weld couplings. The joints must meet ASTM D 3212 specifications. The authorized agent may approve other piping materials for use. The minimum diameter of the inlet and outlet piping shall be four (4) inches. The inlet and outlet shall utilize a tee-pipe fitting on the interior of the grease trap/interceptor. The tee-pipe of the inlet and outlet shall extend to within twelve (12) inches of the bottom and at least five (5) inches above the static liquid level of the tank.

8. The grease trap/interceptor shall be set level on a consolidated, stable base so that no settling or tipping of the grease trap/interceptor can occur.

9. No fixture or drain other than those listed in subsection (b)(1)(A) of the general shall be connected to the grease trap/interceptor unless approved by the authorized agent.

10. The grease trap/interceptor shall be located so as to maintain separation distances from well water supplies based on flow at the distances set forth in Section 19-13-B51d of the Public Health Code.

11. Minimum separation distances shall be maintained between the grease trap/interceptor and items such as but not limited to buildings, watercourses, drains, etc. as listed in local municipal ordinances.

12. Should the authorized agent notify the permittee that testing is required, the testing shall be performed in either one of the following manners:
    a. Vacuum Test - Seal the empty tank and apply a vacuum to four (4) inches of mercury. The tank is acceptable if 90% of vacuum is held for two (2) minutes.

b. Water-Pressure Test - Seal the tank, fill with water, and let stand for twenty-four (24) hours. Refill the tank. The tank is acceptable if the water level is held for one (1) hour.

13. The outlet discharge line from the grease trap/interceptor shall be directly connected to a sanitary sewer.

2.13 MANHOLES

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. Normal-Traffic H-20, Pre-cast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.

1. Diameter: 48 inches minimum, unless otherwise indicated with provision for rubber gasketed joints.
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: 8-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
4. Riser Sections: 5-inch minimum thickness, and lengths to provide depth indicated.
5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. The manhole componence shall be watertight and constructed of concrete or other durable material. All structural seams and/or lifting holes shall be grouted with non-shrinking cement or similar material and coated with a waterproof sealant. In areas where seasonal high ground water is at an elevation greater than the bottom of the manhole, but below the top of the manhole, the exterior of the manhole including the exterior top, sides and bottom shall be coated with a waterproof sealant creating a water tight condition for the structure. In areas where seasonal high ground water is at an elevation greater than the top of the manhole, the exterior of the manhole extensions to grade shall be coated with a waterproof sealant creating a watertight condition for the extension.
7. Gaskets: ASTM C 443, rubber.
8. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and cover.
9. Steps: Copolymer polypropylene plastic steel reinforced, individual steps or ladder. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
10. Flexible, Watertight Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

C. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch diameter cover. Include indented top design with lettering "DANBURY" cast into cover see detail.

2.14 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

C. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: 1 percent through manhole.
      b. Benches: Concrete, sloped to drain into channel.
      c. Slope: 4 percent.

2.15 PROTECTIVE COATINGS

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. Description: One- or two-coat, coal-tar epoxy; 15-mil minimum thickness, unless otherwise indicated; factory or field applied to the following surfaces:
   1. Concrete Manholes: On exterior surface.
   2. Manhole Frames and Covers: On surfaces that will be exposed to sewer gases.

PART 3 - EXECUTION

3.1 EARTHWORK

A. A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.
   1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.3 PIPING APPLICATIONS

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. General: Include watertight joints.

C. Gravity-Flow Piping: Use the following:
   1. NPS 8 and NPS 10: PVC sewer pipe and fittings, solvent-cemented joints, or gaskets and gasketed joints.

3.4 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. Special Pipe Couplings: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.
   1. Use the following pipe couplings for non-pressure applications:
      a. Sleeve type to join piping, of same size, or with small difference in OD.
      b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
      c. Bushing type to join piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

C. Special Pipe Fittings: Use where indicated. Include PE film, pipe encasement.

3.5 INSTALLATION

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.

C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

D. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

E. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
   1. Install gravity-flow piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.

F. Extend sanitary sewerage piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.

3.6 EXECUTION – GENERAL SEWER MAIN

A. The program of earthwork, rock excavation, dewatering, traffic control, support of excavation, environmental protection, backfilling and compacting, handling sanitary sewage and storm water flows, etc., shall be done in accordance with the applicable Sections of the Specifications.

B. Removal and disposal of existing sewer and appurtenances shall be done in accord with the MDC Project Manual, current edition.

C. Where and as shown on the Contract Drawings, the Contractor will be required to remove and relay portions of existing sanitary or storm house connection laterals, in conjunction with the installation of new sanitary sewers and storm drains. At certain locations other utility owners will be performing utility relocation work. The Contractor shall coordinate his scheduling of work of said utility owners.

D. Pipe shall be installed in accordance with applicable pipe section of these Specifications.

E. As soon as the excavation is completed to the normal grade of the bottom of the trench, refer to the MDC Standard Details Manual for specific subbase depths and materials required. Pipe shall be laid in a dry trench. Blocking under the pipe will not be permitted.

F. Pipe shall be connected at joints with the use of a push-on integral rubber gasket on all plastic pipe conforming with the designated ASTM specifications.

G. Wyes, bends, inlets, tees, chimneys, etc., shall be installed as shown or directed in the pipeline. The Contractor shall have a sufficient quantity of fittings on hand that can be installed as required around existing utilities as directed by the Engineer.

H. Existing house connection laterals (sanitary and storm) shall be temporarily reconnected to the new sanitary sewer or storm drain until such time as the permanent connection can be made.

I. Backfill material shall be placed in lifts as specified in Section 312000 “Earth Moving” and Section 321216 “Asphalt Paving” and compacted in the full width and length of the trench up to the approved height above the pipe and below the surface to be paved as specified.

J. Trench stabilization and support systems shall be used for all installation work and shall conform with OSHA regulations. Where indicated on the Contract Drawings and as specified or ordered by the Engineer, the excavation support system shall be installed and either be removed or left in-place, as determined by the Engineer.

K. Trench dams shall be placed at the locations shown on the Contract Drawings. Backfill shall be placed evenly on each side of the trench dam as indicated in the MDC Standard Details Manual.

3.7 INSPECTION – SEWER MAIN

A. Each pipe unit shall be inspected before being installed. No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16 in. per ft. of length with a maximum deviation of 3/4 in. per length of pipe. If a piece of pipe fails to meet this required check for straightness, it shall be rejected and removed from the site. Any pipe unit or fitting discovered to be defective either before or after installation shall be removed and replaced with a sound unit.

3.8 INSTALLATION – SEWER MAIN

A. Pipes and fittings complying with ASTM F949 shall be installed in accordance with ASTM D2321.

B. All underdrains shall be match-in-kind. Refer to applicable Municipality Standards.

C. The pipe bedding shall be as shown in the MDC Standard Details Manual and in accordance with Section 02721 of the MDC Project Manual.

D. Suitable bell holes shall be provided, so that after placement, only the barrel of the pipe receives bearing pressure from the supporting material.

E. All pipe and fittings shall be cleared of all debris, dirt, etc., before being installed and shall be kept clean until accepted in the completed work.

F. Pipe and fittings shall be installed to the lines and grades indicated on the Contract Drawings, in the MDC Standard Details Manual or as required by the Engineer. Care shall be taken to ensure true alignments and gradients.

G. Before any joint is made, the previously installed unit shall be checked to assure that a closed joint with the adjoining unit has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to the required grade by striking it with a shovel handle, timber or other unyielding object.

H. All joint surfaces shall be cleaned. Immediately before jointing the pipe, the bell or groove shall be lubricated in accordance with the manufacturer's recommendation. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket. Suitable devices shall be used to force the pipe units together so that they will fit with a minimum open recess inside and outside and have tightly sealed joints. Care shall be taken not to use such force as to wedge apart and split the bell or groove ends.

I. Joints shall not be "pulled" or "crimped" unless permitted by the Engineer.

J. Where any two pipe units do not fit each other closely enough to enable them to be properly jointed, they shall be removed and replaced with suitable units and new gaskets.

K. Details of gasket installation and joint assembly shall follow the directions of the manufacturers of the joint material and of the pipe, all subject to review by the Engineer. The resulting joints shall be watertight and flexible.

L. All premolded gasket joint polyvinyl chloride pipe of a particular manufacturer may be rejected if there are more than five unsatisfactory joint assembly operations or "bell breaks" in 100 consecutive joints, even though the pipe and joint conform to the appropriate ASTM Specifications as hereinbefore specified. If the pipe is unsatisfactory, as determined above, the Contractor shall, if required, remove all pipe of that manufacturer of the same shipment from the work and shall furnish pipe from another manufacturer which will conform to all of the requirements of these specifications.

M. Open ends of pipe and branches shall be closed with polyvinyl chloride stoppers secured in place in an acceptable manner.

N. After each pipe has been properly bedded, enough bedding material shall be placed between the pipe and the sides of the trench, and thoroughly compacted, to hold the pipe in correct alignment. Bell holes, provided for jointing, shall be filled with bedding material and compacted. Bedding above the spring line of the pipe (see MDC Standard Details Manual for material) shall be placed and compacted to complete the pipe bedding.

O. The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench. At all times pipe installation is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs, or by other acceptable means.

P. If water is in the trench when work is to be resumed, the plug shall not be removed until suitable provisions have been made to prevent water, earth, or other substances from entering the pipe.

Q. Pipelines shall not be used as conductors for trench drainage during construction.

3.9 ALLOWABLE PIPE DEFLECTION – SEWER MAIN

A. Pipe provided under this specification shall be so installed as to not exceed a maximum deflection of 5 percent. Such deflection shall be computed by multiplying the amount of deflection (nominal diameter less minimum diameter when measured) by 100 and dividing by the nominal diameter of the pipe.

B. Upon completion of a section of sewer, including placement and compaction of backfill, the Contractor shall measure the amount of deflection by pulling a specially designed gage assembly through the completed section. The gage assembly shall be in accordance with the recommendations of the pipe manufacturer and be acceptable to the Engineer.

C. Should the installed pipe fail to meet this requirement, the Contractor shall do all work to correct the problem as the Engineer may require without additional compensation.

3.10 CLEANING – SEWER MAIN

A. Care shall be taken to prevent earth, water, and other materials from entering the pipeline. As soon as possible after the pipe and manholes are completed, the Contractor shall clean out the pipeline and manholes, being careful to prevent soil, water, and debris from entering any existing sewer.

3.11 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. General: Joint and install pipe and fittings according to installations indicated.

C. PVC Sewer Pipe and Fittings: As follows:
   1. Joint pipe and gasketed fittings with gaskets according to ASTM D 2321.
   2. Joint profile sewer pipe fittings with gaskets according to ASTM D 2321 and manufacturer's written instructions.
   3. Install according to ASTM D 2321.

D. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.

E. Joint piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

F. Install with top surfaces of components, except piping, flush with finished surface.

3.12 GREASE TRAP INSTALLATION

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. The Grease Trap shall be installed according to the manufacturer's specifications unless otherwise directed by the Engineer.

3.13 MANHOLE INSTALLATION

A. Comply with requirements of the Town of Rocky Hill Engineering Department.
   1. General: Install manholes, complete with appurtenances and accessories indicated.

B. Form continuous concrete channels and benches between inlets and outlet.

C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.

D. Install precast concrete manhole sections with gaskets according to ASTM C 891.

3.14 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.15 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
   2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Structures: Excavate around structure as required and use one procedure below:
   1. Remove structure and close open ends of remaining piping.
   2. Remove top of structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
   3. Backfill to grade according to Division 2 Section "Earthwork."

3.16 CLEANING SEWER MAINS

A. At the conclusion of the Work, thoroughly clean all pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered the pipes during the construction period. Debris cleaned from the lines shall be removed from the low end of the pipeline. If after this cleaning, obstructions remain, they shall be removed. After the pipelines are cleaned and if the groundwater level is above the pipe or following a heavy rain, the Engineer will examine the pipes for leaks. If any defective pipes or joints are discovered, they shall be repaired or replaced by the Contractor.

3.17 TELEVISION INSPECTION SEWER MAINS

A. All new sewer pipelines shall be television inspected by the Contractor prior to acceptance to assure proper jointing and flow characteristics. Television inspections shall not be scheduled until construction of other utilities in the same area is completed and pipeline under consideration has been backfilled and compacted to sub-grade elevation. Television inspection will be performed after the pipelines have been cleaned and also for a second time at end of the 1-year maintenance period. Contractor will be required to repair any defects noted at this time at no additional cost to the Owner.

3.18 TESTING SEWER MAINS

A. General
1. The Contractor shall test the first section of new mainline pipe and new service pipe as soon as it is installed to demonstrate that the work conforms to these Specifications. The initial test section shall not be more than 500-ft of pipeline.
2. Testing of pipe shall closely follow pipe laying. The Contractor shall have no more than 1000-ft of untested sewer or drain constructed at any time.

B. Infiltration Test
1. Pipe shall be tested for infiltration if groundwater level is a minimum of 2 feet above the crown at the highest elevation of the pipe for the full length of section to be tested, after the backfill has been placed and the ground water allowed to return to normal elevation. Infiltration tests shall be made under the supervision of the Engineer and the length of line to be tested shall be the length between adjacent manholes. The allowable infiltration shall be 100 gals per inch of diameter per day per mile of pipe in PVC, DI and RCP pipe for each section tested. There shall be no gushing or spurting leaks.
2. If an inspection of the completed sewer or any part thereof shows pipes or joints which allow noticeable infiltration of water, the defective work or material shall be replaced or repaired as directed, at no additional cost to the Owner.
3. Rates of infiltration shall be determined by means of V-Notch weirs, pipe spigots, or by plugs in the end of the pipe to be furnished and installed in an approved manner and at such times and locations as may be directed by the Engineer.

C. Exfiltration Test
1. Leakage tests by exfiltration shall be made before or after backfilling at the discretion of the Engineer. The length of pipe to be tested shall be such that the head over the crown at the upstream crown is not less than 2-ft and the head over the downstream crown is not more than 4-ft. The pipe shall be plugged by pneumatic bags or mechanical plugs in such a manner that the air can be released from the pipe while it is being filled with water. Before any measurements are made, the pipe shall be kept full of water long enough to allow absorption and the escape of any trapped air to take place. Following this, a test period of at least one hour shall begin. Provisions shall be made for measuring the amount of water required to maintain the water at a constant level during the test period.
2. If any joint shows an appreciable amount of leakage, the jointing material shall be removed and the joint repaired. If any pipe is defective, it shall be removed and replaced. If the quantity of water required to maintain a constant level in the pipe does not exceed 100 gals per inch of diameter per day per mile of pipe and if all the leakage is not confined to a few joints, workmanship shall be considered satisfactory. If the amount of leakage indicates defective joints or broken pipes, they shall be corrected or replaced.

D. Air Testing
1. When the Engineer specifies or directs that leakage tests shall be made using the low-pressure air test method, the Contractor will be required to provide all equipment, test plugs in the required

sizes, appurtenances, connecting hose or pipe, labor and materials necessary to conduct and control the test as herein specified. All testing shall be performed in accordance with the procedures described in ASTM C828.

2. All tests shall be conducted on the completed sewer pipeline between manholes. Testing of shorter sections of pipeline will only be permitted with the approval of the Engineer.
3. The Contractor is cautioned regarding the importance of properly installing the end caps used to plug hubs, wyes, bends, ends of laterals, and other inlets, and securing them against movement during installation of sewer. Failure to take this precaution can cause a properly installed sewer pipeline to fail a low-pressure air test.
4. The Contractor is further cautioned regarding the safety of personnel during the test. Low-pressure air can exert a substantial force on a pipe plug, even on all diameter pipe plugs. The Contractor will be responsible to insure that all plugs utilized are in good condition and that they will not be pressurized beyond the limits recommended by their manufacturer.
5. No one will be permitted in a manhole containing a plug while air is under pressure in the pipeline being subjected to low-pressure air testing.
6. All gages, controls, and appurtenances for equipment used to conduct the test will be located outside of manholes. Connections to the line under test, test plugs, and other equipment will be made with hose or pipe extensions which will safely contain the pressures necessary to conduct and control the test.
7. Immediately prior to testing, all lines will be cleaned and flushed with water. Pipe manufactured in accordance with ASTM Specification C-76, where applicable, shall be soaked for a period of 12 hours to saturate the pipe wall prior to testing with low-pressure air.
8. The equipment used to introduce the low-pressure air into the sewer line shall include a safety valve, or release device, located in the equipment at a point which will insure that, during the build-up of test pressure, the pipeline being tested will not be subjected to an internal pressure that could damage a properly installed pipeline.
9. The gage used to measure the drop in pressure shall have a 4-inch diameter face with a scale of 0 to 15 PSI (pounds per square inch) in 0.1 PSI increments, or as approved by the Engineer.
10. The Contractor shall determine the elevation of the ground water table in the area of the pipeline being subjected to the low-pressure air test in a manner approved by the Engineer.
11. After cleaning and flushing the line, plugs will be installed in the pipeline being subjected to the low-pressure air test and braced as necessary to secure the plugs in place.
12. Utilizing the approved equipment, air at low pressure will be slowly introduced into the pipeline until the pressure within the pipeline being tested increases to 4 PSIG greater than the back pressure exerted by the ground water table over the pipe being tested, but not greater than 9 PSIG, (back pressure = 1 PSIG per 2.31 feet of water) as determined above (if the water table is not at a level above the pipe, the test pressure should be brought up to 4 PSIG). Allow at least 2 minutes to elapse prior to starting the test. If necessary, allow a small amount of air to slowly enter the pipeline in order to maintain a pressure of 4 PSIG above the back pressure due to the water table, or 4 PSIG if there is no back pressure to compensate for.
13. Disconnect the supply air hose from the source of air and allow the air pressure within the pipe being tested to drop to 3.5 PSIG above the backpressure due to the existing ground water table (or to 3.5 PSIG if there is no water table). At this point, start measuring the time for the pressure in the pipeline to drop 1 PSIG (or to drop to 2.5 PSIG if there is no back pressure due to a water table).
14. The time required to drop 1 PSIG shall not be less than that indicated in Table 1 for the size and length of pipeline being tested. If the time is less than that indicated in Table 1, the pipeline will be considered to have failed the test (See Table 1).
15. Any section of the sewer line which fails to meet this test will be repaired or replaced as necessary by the Contractor, and retested at no additional expense to the Owner.
16. The Contractor will be responsible for all costs and delays incurred due to efforts to locate and repair any leaks in any sewer line which fails the lowpressure air test, regardless of whether the

failure is due to workmanship, material failure, the result of an improperly installed or braced end cap; or any sewer line damaged due to failure to provide a properly sized and operable safety valve or pressure relief device, on the testing equipment for protection of the pipeline being tested. No sewer line will be considered acceptable until it successfully passes the requirements of this test unless the requirement is waived by the Engineer.

17. All testing will be conducted by the Contractor or his approved Subcontractor in the presence of the Engineer. The Contractor or his Subcontractor shall keep a written record which will show the results of the tests conducted. These records should include sufficient data on length of line, pressure levels, time for pressure drop and related features noted during the testing of each segment of the line. A copy of these records shall be given to the Owner.

E. Allowable Deflection Test

1. Pipe deflection measured not less than 90 days after the backfill has been completed as specified shall not exceed 5 percent. Deflection shall be computed by multiplying the amount of deflection (nominal diameter less minimum diameter when measured) by 100 and dividing by the nominal diameter of the pipe.
2. Deflection shall be measured with a rigid mandrel (Go/No Go) device cylindrical in shape and constructed with a minimum of 9 evenly spaced arms or prongs. Drawings of the mandrel with complete dimensions shall be submitted to the Engineer for each diameter of pipe to be tested. The mandrel shall be hand pulled through all sewer lines.
3. Any section of sewer not passing the mandrel shall be uncovered at no additional cost to the Owner and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested at no additional cost to the Owner. Retested pipe shall not deflect more than 4 percent.

F. Sewer Pipe Joint Testing

1. Existing hydrostatic head shall be established by inserting a pipe probe into the backfill material at the crown of the pipe at the downstream manhole and applying pressure until equilibrium is attained. This is the back pressure that all test pressures for that section of line shall be increased by.
2. A precise pressure of 4 psi above the existing hydrostatic head shall be applied to each joint. Once the pressure of 4 psi above hydrostatic head at the joint has been recorded on the gauge above ground, the water flow shall be stopped and the pressure gauge observed for 30 seconds. Should the pressure on the joint drop 0.5 psi or more within 30 seconds, the joint will have failed the test. Joints that fail the test shall be repaired as directed by the Engineer and re-tested by the same procedure until the joints pass the pressure test.
3. During the joint testing program, complete records shall be kept, recording the location of the manhole section in which the testing is done, location of each joint tested, test pressures used, and the test results.
4. Pipe joints that fail the joint test shall be repaired to the satisfaction of the Engineer and shall be subject another joint test at the direction of the Engineer.
5. Place attest packer inside pipe and test every joint.

3.19 FIELD QUALITY CONTROL

A. Comply with requirements of the Town of Rocky Hill Engineering Department.

B. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.

1. Place plug in end of incomplete piping at end of day and when work stops.

2. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.

C. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
1. 1. Submit separate reports for each system inspection.
2. 2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Re-inspect and repeat procedure until results are satisfactory.

D. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate reports for each test.
5. If authorities having jurisdiction do not have published procedures, perform tests as follows:
   a. Sanitary Sewerage: Perform hydrostatic test.
      1) Allowable leakage is maximum of 50 gal. per inch of nominal pipe size per mile of pipe, during 24-hour period.
      2) Close openings in system and fill with water.
      3) Purge air and refill with water.
      4) Disconnect water supply.
      5) Test and inspect joints for leaks.
      6) Option: Test ductile-iron piping according to AWWA C600, Section "Hydrostatic Testing." Use test pressure of at least 10 psig.

   b. Sanitary Sewerage: Perform air test according to UNI-B-6.
      1) Option: Test concrete piping according to ASTM C 924 (ASTM C 924M).
6. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).
7. Leaks and loss in test pressure constitute defects that must be repaired.
8. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.20 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

3.21 AS-BUILT

A. Final As-built of all items location and elevations by a CT Licensed Land Surveyor in paper, Mylar and AutoCad format to be provided for owner and irrigation system installer and engineer.

B. Final As-built of all items location and elevations .dwg file in AutoCAD Civil 3D format of as built prepared by a CT Licensed Land Surveyor with Civil 3D pipe networks.

TABLE 1

MINIMUM TIME REQUIRED FOR A PRESSURE TEST DROP OF 1 PSIG AS REQUIRED

IN LOW PRESSURE AIR TEST SPECFICATION – MINUTES: SECONDS

(BASED ON 0.0015CFM/SQ.FT.)

Pipe Diameter (in.)	Specification Time for Length (L) Shown (min:sec)								
	100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.	500 ft.
4	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:47
6	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24	7:07
8	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24	12:40
10	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48	19:47
12	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38	28:29
15	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04	45:51
18	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41	64:06
21	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31	87:15
24	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33	113:58

END OF SECTION 22 13 13

SECTION 22 3000 - PLUMBING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Hose bibs.
2. Wall hydrants.
3. Water hammer arrestors.
4. Trap primers.
5. Thermostatic mixing valves.
6. Expansion tanks.
7. Floor drains.
8. Floor sinks.
9. Recessed valve boxes.
10. Roof drains.
11. Parapet drains.
12. Canopy and cornice drains.
13. Special purpose downspout covers.
14. Downspout nozzles.
15. Area drains.
16. Trench Drains

B. Related Sections:
1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
2. Section 22 04 00 – General Conditions for Plumbing Trades
3. Section 22 05 00 – Common work results for Plumbing
4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
5. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
6. Section 22 05 23 - General-Duty Valves for Plumbing Piping
7. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
8. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
9. Section 22 05 53 – Identification for Plumbing Piping and Equipment
10. Section 22 07 00 - Plumbing Insulation
11. Section 22 15 00 – Specialty Plumbing Systems and Equipment
12. Section 22 34 00 – Fuel Fired Domestic Water Heaters
13. Section 22 40 00 – Plumbing Fixtures

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
2. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
3. ANSI A112.26.1 - Water Hammer Arrestors.
4. ASME A112.21.1 - Floor Drains.
5. ASME A112.21.2M - Roof Drains.

B. Plumbing Drainage institute:
1. PDI WH-201 – Water Hammer Arresters.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

C. Product Data: Provide component sizes, rough-in requirements, service sizes, capacities and finishes.

D. Manufacturer's Installation Instructions: Submit installation methods and procedures. Indicate assembly and support requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.

G. Valves: Submit manufacturers catalog information with valve data and ratings for each service.

H. Hangers and Supports: Submit manufacturers catalog information including load capacity.

I. Storm Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

J. Sanitary Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

C. Project Record Documents: Record actual locations of equipment and clean-outs.

1.5 QUALITY ASSURANCE

A. Record actual locations of equipment, cleanouts, etc.

B. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.

C. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.

D. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept specialties on site in factory packaging. Inspect for damage.

C. Protect installed specialties from damage by securing areas.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

1.10 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Provide two loose keys for hose bibs and wall hydrants

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
1. JR Smith.
2. Watts.
3. Josam.
4. Wade.
5. Zurn.
6. MiFab.
7. Precision Plumbing Products
8. Substitutions: Section 01 60 00 - Product Requirements.

2.2 HOSE BIBS

A. Manufacturers:
1. Woodford.
2. Josam.
3. Wade.
4. Zurn.
5. Watts.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. ANSI/ASSE 1011 Bronze or brass with integral mounting flange, vacuum breaker.

2.3 WALL HYDRANTS

A. Manufacturers:
1. Woodford.
2. Josam.
3. Wade.
4. Zurn.
5. Watts.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Wall Hydrant: ANSI/ASSE 1019; self-draining type, freeze proof with removable key and integral vacuum breaker.

2.4 WATER HAMMER ARRESTORS

A. Manufacturers:
1. Precision Plumbing Products.
2. Woodford.
3. Josam.
4. Wade.
5. Zurn.
6. Watts.
7. Substitutions: Section 01 60 00 - Product Requirements.

B. ANSI A112.26.1; sized in accordance with PDI, precharged, suitable for operation in temperature range -100 to 300 degrees F (-73 to 149 degrees C) and maximum 250 psig (1700 kPa) working pressure.

2.5 TRAP PRIMERS

A. Manufacturers:
1. Woodford.
2. Josam.
3. Wade.
4. Zurn.
5. Watts.
6. PPP.
7. Substitutions: Section 01 60 00 - Product Requirements.

B. ASSE 1018: Corrosion resistant brass, temperature range –40 to 450 degrees, ½” male inlet and ½” female outlet, pressure operating range 35 to 75 psig.

2.6 THERMOSTATIC MIXING VALVES

A. Manufacturers: Symmons model as scheduled on the drawings.

B. Other acceptable manufacturers offer equivalent products:
1. Lawler
2. Leonard
3. Powers

4. Watts

C. Accessories:
1. Check valves on inlets.
2. Volume control shut-off valve on outlet.
3. Stem thermometer on outlet.
4. Strainer stop checks on inlets.

D. Cabinet: 16 gage (1.5 mm) prime coated steel, for recessed mounting with keyed lock.

2.7 EXPANSION TANKS

A. Manufacturers:
1. Amtrol.
2. Taco.
3. Bell and Gossett.
4. Watts.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Construction: Welded steel, ASME labeled, tested and stamped in accordance with Section 8D of ASME Code; supplied with National Board Form U-1, rated for working pressure of 125 psig (860 kPa), with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

2.8 RECESSED VALVE BOXES

A. Manufacturers: Symmons model as scheduled on the drawings.

B. Other acceptable manufacturers offer equivalent products:
1. Acorn
2. Josam
3. Potter Roemer

C. Washing Machine: Plastic preformed rough-in box with brass water control valve, socket for 2 inch waste, and cover.

D. Refrigerator: Plastic preformed rough-in box with brass valves with wheel handle, slip in finishing cover.

2.9 FLOOR DRAINS

A. Manufacturers:
1. Watts
2. JR Smith
3. Zurn
4. Josam
5. Wade
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Floor Drain: ASME A112.21.1; cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, trap primer connection, and round, adjustable nickel-bronze strainer with maximum ½"grate spacing.

C. Floor Drain: ASME A112.21.1; cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, trap primer connection and round, adjustable round nickel-bronze strainer with maximum ½"grate spacing, removable perforated sediment bucket.

2.10 FLOOR SINKS

A. Manufacturers:
1. Watts
2. JR Smith
3. Zurn
4. Josam
5. Wade
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Floor Sink: Square lacquered cast iron body with integral seepage pan, epoxy coated interior, dome strainer, clamp collar, sediment bucket, epoxy coated, nickel bronze frame and half grate, trap primer connection.

2.11 CLEANOUTS

A. Manufacturers:
1. Watts
2. JR Smith
3. Zurn
4. Josam
5. Wade
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Exterior Surfaced Areas: Round Square cast nickel bronze access frame and non-skid cover.

C. Exterior Unsurfaced Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket.

D. Interior Finished Floor Areas: Lacquered Galvanized cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round scored cover with gasket in service areas and round square depressed cover with gasket to accept floor finish in finished floor areas.

E. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket, and round stainless steel access cover secured with machine screw.

F. Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.12 BACK WATER VALVES

A. Manufacturers:
1. JR Smith
2. Zurn
3. Josam
4. Wade
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Cast Iron: ASME A112.14.1; lacquered galvanized cast iron body and cover, brass valve, 6 inch extension sleeve, and access cover.

2.13 SEDIMENT INTERCEPTORS

A. Manufacturers:
1. JR Smith
2. Zurn
3. Josam
4. Wade
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Epoxy coated cast iron body and secured cover with removable stainless steel sediment bucket.

2.14 DILUTION NEUTRALIZATION TANKS

A. Manufacturers:
1. Zurn
2. Orion
3. Wade
4. T&C Plastics
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Polypropylene tank, bolted cover, inlet & outlet for piping connections, vent connection.

2.15 ROOF DRAINS

A. Manufacturers:
1. Zurn
2. Josam
3. JR. Smith
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Roof Drain (RD):
1. Assembly: ASME A112.21.2M.
2. Body: cast iron with sump.
3. Strainer: Removable polyethylene dome.
4. Accessories: Coordinate with roofing type, refer to architectural drawings and specifications.
   a. Membrane flange and membrane clamp with integral gravel stop.
   b. Adjustable under deck clamp.
   c. Roof sump receiver.
   d. Waterproofing flange.
   e. Controlled flow weir.
   f. Leveling frame.
   g. Adjustable extension sleeve for roof insulation.
   h. Perforated or slotted ballast guard extension for inverted roof.
   i. Perforated stainless steel ballast guard extension.

C. Roof Drain (OD):
1. Assembly: ASME A112.21.2M.
2. Body: cast iron with sump.

3. Strainer: Removable polyethylene dome.
4. Pipe extended to 4” inches above flood elevation.
5. Accessories: Coordinate with roofing type refer to architectural drawings and specifications.
    a. Membrane flange and membrane clamp with integral gravel stop.
    b. Adjustable under deck clamp.
    c. Roof sump receiver.
    d. Waterproofing flange.
    e. Controlled flow weir.
    f. Leveling frame.
    g. Adjustable extension sleeve for roof insulation.
    h. Perforated or slotted ballast guard extension for inverted roof.
    i. Perforated stainless steel ballast guard extension.

2.16 PARAPET DRAINS

A. Manufacturers:
1. Zurn
2. Josam
3. JR. Smith
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Galvanized cast iron body with aluminum flashing clamp collar and nickel bronze sloping flush grate.

2.17 CANOPY AND CORNICE DRAINS

A. Manufacturers:
1. Zurn
2. Josam
3. JR. Smith
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Galvanized cast iron body with aluminum flashing clamp collar and nickel bronze flat strainer.

2.18 SPECIAL PURPOSE DOWNSPOUT COVER

A. Manufacturers:
1. Wade
2. Josam
3. Mifab
4. Zurn
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Brass with stainless steel mesh liner, vandal proof lock nut, and pipe clamp securing holes.

2.19 DOWNSPOUT NOZZLES

A. Manufacturers:
1. Wade
2. Josam

3. Mifab
4. Zurn
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Polished finish body and wall flange round with straight offset bottom section.

2.20 TRENCH DRAINS

A. Manufacturers:
1. Watts
2. JR Smith
3. Zurn
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Trench Drain: Pre-Sloped Trench Drain System with 6”(152) wide x 48”(1219) long (standard) ductile iron frame, UV stabilized glass-filled polypropylene channels with integral 4”(102) no hub bottom or end outlet(s). System shall be frame-anchored, with (specify) grating to suit DIN Class (specify) load rating. System to include frame connectors, grate lockdowns, and construction covers. Installation to be performed in accordance with manufacturer’s recommendations.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify walls and floor finishes are prepared and ready for installation of fixtures.

C. Verify electric power is available and of correct characteristics.

3.2 PREPARATION

A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.3 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Install cleanouts for sanitary and storm piping at bends of 90 degrees or greater, and as required by all applicable codes, regulations, ordinances, and laws imposed by jurisdictional authorities whether or not they are shown on drawings.

C. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

D. Cleanouts shall be same size as the pipes served, up to 4 inches; 5 and 6 inch pipes shall have 4 inch cleanouts; 8 inch pipes shall have 6 inch cleanouts; 10 inch pipes and larger shall have 8 inch cleanouts.

E. Encase exterior cleanouts in concrete flush with grade.

F. Install components level and plumb.

G. Install piping penetrating roofed areas to maintain integrity of roof assembly.

H. Install water hammer arrestors for all quick closing valves whether or not they are shown on drawings.

I. Install water hammer arrestors with isolation valve in accessible locations, provide with access doors, size, color and exact location to be coordinated by plumbing contractor with architect and architectural drawings.

J. Trap primers shall be provided and installed to serve all floor drains floor sinks and indirect drains, provide distribution units as required for all drains.

K. Trap primer connections shall be installed on cold water piping 1 ½ inch diameter or less.

L. When floor finish includes tile, floor drain strainers and cleanout covers shall be provided to match tile shape to best extend possible. Square shall be used when square tiles are provided. When tile is a different shape, the contractor shall confirm with architect what shape shall be provided.

3.4 INTERCEPTORS

A. Provide sediment interceptors for all art room sinks, maintain clearances as required by the manufacturer.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop-drawings. Confirm location and size of drains before rough in and installation.

3.6 ADJUSTING

A. Section 01 77 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

3.7 CLEANING

A. Section 01 77 00 - Execution and Closeout Requirements: Final cleaning.

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 77 00 - Execution and Closeout Requirements: Protecting installed construction.

3.9 COMMISSIONING 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 this equipment with the Commissioning Agent.

END OF SECTION

SECTION 223400 - FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Commercial gas-fired water heaters.
2. Packaged water heating systems.

B. Related Sections:
1. Section 22 04 00 – General Conditions for Plumbing Trades
2. Section 22 05 00 – Common work results for Plumbing
3. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
4. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
5. Section 22 05 23 - General-Duty Valves for Plumbing Piping
6. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
7. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
8. Section 22 05 53 – Identification for Plumbing Piping and Equipment
9. Section 22 07 00 - Plumbing Insulation
10. Section 22 15 00 – Specialty Plumbing Systems and Equipment
11. Section 22 30 00 – Plumbing Specialties
12. Section 22 40 00 – Plumbing Fixtures

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI Z21.10.1 - Gas Water Heaters Vol. I Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less.
2. ANSI Z21.10.3 - Gas Water Heaters - Vol. III Storage, with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous Water Heaters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. American Society of Mechanical Engineers:
1. ASME PTC 25 - Pressure Relief Devices.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. National Fire Protection Association:
1. NFPA 54 - National Fuel Gas Code.

E. United States Department of Energy:
1. DOE 10 CFR - Uniform Test Method for Measuring the Energy Consumption of Furnaces.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.

C. Product Data:
   1. Water Heaters: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements. Submit electrical characteristics and connection locations.
   2. Pumps: Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

D. Manufacturer's Installation Instructions: Submit mounting and support requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit replacement part numbers and availability.

1.5 QUALITY ASSURANCE

A. ASME Compliance: Water Heater shall bear ASME HLW stamp and be National Board listed.

B. Listing: The water heater shall be listed ETL listed to UL 795 or ANSI Z21.10.3/CSA 4.3 “Gas Water Heaters”

C. The water heater will comply shall current ASHRAE 90.1 requirements.
Water heaters with full rated input of 800,000 BTU shall operate at a minimum 94% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).

D. Maintain one copy of each document on site.

E. Water heater manufacturer certified to the ISO 9001 International Quality System.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience,

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Products storage and handling requirements.

B. Accept water heaters on site in original labeled cartons. Inspect for damage.

C. Protect tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for domestic water heaters packaged water heating systems.

1.11 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Storage tank, heating surfaces, and combustion chamber will have a manufacturer's **15-year** warranty (8 years non-prorated, 7 years prorated) covering manufacturing or material defects, waterside or fire side corrosion, leaks, and/or the production of rusty water. Warranties must be directly provided from the water heater manufacturer. Warranties provided by distributors, contractors, sales representatives or third party insurers will not be accepted.

C. Burner and all heater parts: 1 year

PART 2 PRODUCTS

2.1 COMMERCIAL GAS FIRED STORAGE TYPE CONDENSING WATER HEATERS

A. Acceptable Manufacturers:
   1. PVI Conquest 80L130A-GCL
   2. Pre-Approved equal storage type condensing water heater
   3. Skid mounted, packaged, pre-piped boiler and tank system in adherence to section 2.1
      a. Available Manufacturers: Manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum twenty years' experience. The water heaters shall be manufactured by a company that has achieved certification to the ISO 9001Quality Management System.
      b. The water heaters shall be ETL listed as a complete unit. The heater shall satisfy current Federal Energy Policy Act standards for both thermal efficiency and stand-by heat losses as established for gas fired water heaters.
      c. Manufacturers: PVI is the basis of design. Acceptable manufacturers shall be subject to compliance with the requirements of section 2.1 A through L.

2.2 COMMERCIAL GAS FIRED STORAGE TYPE CONDENSING WATER HEATERS

A. Construction: Tank, combustion chamber and fire tubes will be constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2and ASTM G123 - 00(2005) "Standard Test Method for Evaluating Stress-

Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution."

B. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.

C. Substitution Compliance requirements: The water heating system shall be storage type condensing or pre-piped boiler/tank condensing design with appropriate storage tanks and capable of delivering return water back to the boiler below 90 degrees to insure continual condensing operation. The system manufacturer's design must be ETL listed as a complete unit and shall have an efficiency of 96% as tested to Thermal Efficiency based on ANSI Z21.10.3. Submittals must include ETL or equal test results showing conformance to efficiency requirements. This system must include a double wall plate & frame heat exchanged manufactured by Aerco (Smart Plate) or Alpha Laval along with detailed engineering calculations. A complete CAD design must be presented for approval with the submittals showing piping layout, pipe sizes, bypass piping, isolation valves, balance valves, pipe insulation type and thickness, pump size and type (must be all bronze), boiler manufacturer and efficiency, electrical requirements, double wall heat exchanger selection, skid dimensions and tank specifications. Approved boiler manufacturers are Aerco Benchmark and Viessmann VitoCrossal 300. Approved storage tank manufacturers are 90/10 copper nickel tanks from Hubbell or equal unlined storage tanks. Each tank will be piped to an external double wall heat exchanger with a bronze pump capable of delivering the required 932 gph recovery while providing a return water temperature to the boiler below 90 degrees. A boiler efficiency curve will be submitted showing efficiency related to return water temperature. Any additional cost for motor starters, insulation, venting, gas pipe and/or other subcontractor labor shall be included in the submittal for equal substitutions and are the contractor's responsibility.

D. All tank connections/fittings will be non-ferrous or stainless steel.

E. To preserve thermal efficiency, the water heater will not use or require a circulator piped from the hot water outlet to the cold water inlet of the heater for the purpose of temperature control during normal operation. Connection for a building return circulation line will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping.

F. Finished vessel will not require sacrificial or impressed current anodes and none will be used. Water heaters or sidearm storage tanks that employ anode rods of any type will not be acceptable.

G. Combustion will be provided by a premix, fan-assisted surface burner with a gas train meeting UL, ANSI and FM standards for the input specified. Gas train components will capable of self-proportionating gas and air to maintain optimum combustion in response to varying vent pressures. The burner will employ non-linkage modulation utilizing only a VFD drive to vary gas and air.

H. Burner NOx emissions will be less than 20 ppm when corrected to 3% oxygen.

I. Water heater will be a category IV, condensing appliance and vent through PVC or Polypropylene. Water heater will satisfy requirements for sealed combustion. Vents for inlet air and exhaust can terminate in different pressure zones.

J. Capacity:
1. Storage capacity: 130 gallon each heater
2. Input: 800,000 BTU
3. Min recovery rate: 932 gph with 100 deg temperature rise

K. Options shall include condensate neutralization system and other options as listed on the schedule.

L. The water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a building automation system through serial connection using Modbus RTU protocol. An optional protocol gateway for BacNet MSTP/IP or Lonworks will be provided in accordance with the water heated schedule listed on the drawings.

M. Water heater will be certified by the DOE/EPA Energy Star program for commercial water heaters, whereby standby loss and thermal efficiency are independently tested and certified.

N. Water heaters will operate at a minimum 96% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).

O. Controls: As a minimum, the heater will be equipped with the following:
1. Electronic flame monitoring
2. Electronic low water cutoff
3. An immersion operating control
4. an immersion UL listed temperature limiting device
5. an ASME rated temperature and pressure relief valve

P. Start Up: Start up on the unit will be performed by factory trained and authorized personnel. A copy of the start-up report will be provided to the owner. Water heater manufacture will provide a one year service policy from the date of approved start-up.

Q. Substitution shall follow the requirements of section 01 60 00 – Product Requirements

2.3 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Section 26 05 03 and the following:
1. 120 volts, single phase, 60 Hz.

B. Motors: In accordance with Section 22 05 13.

C. Disconnect Switch: Factory mount disconnect switch on equipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Maintain manufacturer's recommended clearances around and over water heaters.

B. Install water heater on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water heater base on each side. Refer to Section 03 30 00.

C. Connect natural gas piping in accordance with NFPA 54.

D. Connect natural gas piping to water heater, full size of water heater gas train inlet. Arrange piping with clearances for burner removal and service. Provide pressure regulator's as required.

E. Connect domestic hot water domestic cold water piping to supply and return water heater connections.

F. Install the following piping accessories. Refer to Section 22 11 00.
   1. On supply:
      a. Thermometer well and thermometer.
      b. Strainer.
      c. Pressure gage.
      d. Shutoff valve.
   2. On return:
      a. Thermometer well and thermometer.
      b. Pressure gage.
      c. Shutoff valve.

G. Install the following piping accessories on natural gas piping connections. Refer to Section 22 11 23.
   1. Strainer.
   2. Pressure gage.
   3. Shutoff valve.
   4. Pressure reducing valve.

H. Install discharge piping from relief valves and drain valves to nearest floor drain.

I. Install circulator and diaphragm expansion tank on water heater.

J. Install water heater trim and accessories furnished loose for field mounting.

K. Install electrical devices furnished loose for field mounting.

L. Install control wiring between water heater control panel and field mounted control devices.

M. Connect flue to water heater outlet, full size of outlet. Refer to Section 23 51 00.

3.2 DEMONSTRATION

A. Refer to Section 01 79 00, for additional training documentation and training requirements.

B. Refer to Section 22 0400, for additional training documentation and training requirements.

C. Demonstrate operation and maintenance procedures.

END OF SECTION

SECTION 224000 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Water closets.
2. Urinals.
3. Sinks.
4. Service sinks.
5. Electric water coolers.
6. Drinking fountains.
7. Showers.
8. Wash fountains.
9. Emergency showers.
10. Emergency Eye and Face Wash.
11. Emergency Combination Shower with Eye and Face Wash.

B. Related Sections:
1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
2. Section 22 04 00 – General Conditions for Plumbing Trades
3. Section 22 05 00 – Common work results for Plumbing
4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
5. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
6. Section 22 05 23 - General-Duty Valves for Plumbing Piping
7. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
8. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
9. Section 22 05 53 – Identification for Plumbing Piping and Equipment
10. Section 22 07 00 - Plumbing Insulation
11. Section 22 15 00 – Specialty Plumbing Systems and Equipment
12. Section 22 30 00 – Plumbing Specialties
13. Section 22 34 00 – Fuel Fired Domestic Water Heaters
14. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ANSI Z124.2 - Plastic Shower Units.
3. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

B. Air-Conditioning and Refrigeration Institute:
1. ARI 1010 - Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.

C. American Society of Mechanical Engineers:
1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
2. ASME A112.18.1 - Plumbing Fixture Fittings.

3. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures.
4. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
5. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
6. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
7. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. Manufacturer's Installation Instructions: Submit installation methods and procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.5 QUALITY ASSURANCE

A. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc., testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

B. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.

C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept fixtures on site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for plumbing fixtures.

1.10 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two sets of faucet washers flush valve service kits sink/lavatory supply fittings shower heads toilet seats

PART 2 PRODUCTS

2.1 FLUSH VALVE WATER CLOSETS

A. Manufacturers:
1. American Standard Plumbing
2. Zurn
3. Eljer Plumbingware
4. Kohler Co.
5. Crane
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Bowl: ASME A112.19.2M; wall hung, siphon jet vitreous china closet bowl, with elongated rim, 1-1/2 inch top or back spud, china bolt caps.

C. Concealed Flush Valve: ASME A112.18.1; concealed rough brass, diaphragm type with exposed chrome plated push button oscillating handle and escutcheon, screw driver stop and vacuum breaker; maximum 1.28 gallon flush volume. Provide water hammer arrestors on all flush valves.

D. Sensor Operated Flush Valve: ASME A112.18.1; concealed rough brass, diaphragm type with low voltage operated solenoid operator, infrared sensor and over-ride button in chrome plated plate, wheel handle stop and vacuum breaker; maximum 1.28 gallon flush volume. Provide water hammer arrestors on all flush valves.

E. Seat: Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.

F. Wall Mounted Carrier: ASME A112.6.1; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.2 WALL HUNG URINALS

A. Manufacturers:
1. American Standard Plumbing
2. Eljer Plumbingware
3. Kohler Co.
4. Crane
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Urinal: ASME A112.19.2M or ANSI Z124.9, vitreous; vitreous china, wall hung washout siphon jet urinal with shields, integral trap, removable stainless steel strainer, 3/4 inch top orback spud, steel supporting hanger.

C. Concealed Flush Valve: ASME A112.18.1; concealed rough brass, diaphragm type with exposed chrome plated push button and escutcheon, wheel handle stop and vacuum breaker; maximum 1/8 gallon flush volume. Provide water hammer arrestors on all flush valves.

D. Sensor Operated Flush Valve: ASME A112.18.1; concealed rough brass, diaphragm type with battery operated solenoid operator, infrared sensor and over-ride button in chrome plated plate, wheel handle stop and vacuum breaker; maximum 1/8 gallon flush volume. Provide water hammer arrestors on all flush valves.

E. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

F. Provide elastomeric gasket complying with ASME A112.4.3, or approved setting compound, for fixture to flange connection.

2.3 SINKS

A. Manufacturers:
1. American Standard Plumbing
2. Eljer Plumbingware
3. Kohler Co.
4. Elkay
5. Just. Mfg.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Single Compartment Bowl: ASME A112.19.3;, 18 gage thick, Type 302 stainless steel. Undermount and undercoated, with 1-1/2 inch chromed brass stainless steel rear offset drain 3-1/2 inch crumb cup and tailpiece, ledge back drilled for trim.

C. Double Compartment Bowl: ASME A112.19.3; 18 gage thick, Type 302 stainless steel. Self-rimming and undercoated, with 1-1/2 inch chromed brass stainless steel drains 3-1/2 inch crumb cups and tailpieces, ledge back drilled for trim.

D. Trim: ASME A112.18.1; chrome plated brass supply with high rise swing spout, vandal proof water economy aerator with maximum 1.0 gpm flow, sensor operated thermostatic mixing valve, furnish with retractable spray when installed in lounge or lunch areas.

E. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, wheel handle screwdriver stop, rigid flexible supplies.

2.4 SHOWERS

A. Manufacturers:
1. Bradley Corp.
2. Aquarius
3. Lasco
4. Aquaglass
5. Kohler Co.
6. Fiat
7. Substitutions: Section 01 60 00 - Product Requirements.

B. Cabinet: Built up shower enclosure, refer to architectural drawings.

C. Floor Receptor: (By others) Furnished with stainless steel entry cap, ½" barrier free entry threshold, 1" cast tiling flange, Shoulder shall be not less than 4" high inside, integral stainless steel drain with 2" drain outlet.

D. Trim: ASME A112.18.1; concealed shower supply with indexed handles, bent shower arm with flow control and adjustable spray ball joint showerhead with maximum 1.5 gpm flow, and escutcheon.

E. Trim: ASME A112.18.1; concealed shower supply with pressure balanced thermostatic mixing valves, integral service stops, ball joint showerhead with maximum 1.5 gpm flow and escutcheon, hand held shower with 60 inch metal hose and slide bar, female inlet.
1. Provide backflow protection in accordance with ASME A112.18.1 or by device complying with ASME 112.18.3.

2.5 ELECTRIC WATER COOLERS

A. Manufacturers:
1. Elkay
2. Hasley Taylor
3. Haws
4. Oasis
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Fountain:
1. recessed handicapped mounted electric water cooler with stainless steel top, #18 gauge, type 304 stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket, refrigerated with integral air cooled condenser and stainless steel grille. Bottle filler feature.
2. Capacity: minimum 7.5 gpm of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
3. Electrical: 115V, single phase, cord and plug for connection to electric wiring system including grounding connector.

2.6 WASH FOUNTAINS

A. Manufacturers:
1. Bradley Corp.
2. Acorn
3. Sloan
4. Willoughby
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Bowl: (One, Two or Three station units), continuous blow constructed from solid surface material, sensor operated, with built in point of use electric water heater, 0.5 gpm flow rate, wall mounted with heavy gauge stainless steel support frame

C. Accessories: self-closing valve, spray head, liquid soap dispenser, thermostatic mixing valve, supporting tube, spud and strainer, operating mechanism, foot levers and rail, combination stop, strainer and check valves.

2.7 SERVICE SINKS

A. Manufacturers:
1. American Standard Plumbing
2. Acorn
3. Fiat
4. Just
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Bowl: 36 x 24 x 10 inch 24 x 24 x 10 inch high molded stone, floor mounted, with one inch wide shoulders, stainless steel bumper guard, stainless steel strainer.

C. Trim: ASME A112.18.1 exposed wall type supply with cross lever handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.

D. Accessories:
1. 5 feet of 1/2 inch diameter plain end reinforced plastic rubber hose.
2. Hose clamp hanger.
3. Mop hanger.

2.8 EMERGENCY SHOWER

A. Manufacturers:
1. Bradley Corp.
2. Chicago Faucet Co.
3. Encon Safety Products
4. Haws Drinking Faucet Co.
5. Guardian
6. Speakman
7. Substitutions: Section 01 60 00 - Product Requirements.

B. ANSI Z358.1; wall-mounted, free standing, self- cleaning, non-clogging 8 inch diameter stainless steel drench shower head with elbow, 1-1/4 inch stainless steel pipe pedestal with floor flange, instant action stay open valve actuated by rigid stainless steel pull rod. Furnish universal emergency sign.

C. Furnish emergency type mixing valve with cold water bypass, stainless steel valve box and temperature gauge.

2.9 EMERGENCY EYE AND FACE WASH

A. Manufacturers:
1. Bradley Corp.
2. Chicago Faucet Co.
3. Encon Safety Products
4. Haws Drinking Faucet Co.
5. Guardian
6. Speakman
7. Substitutions: Section 01 60 00 - Product Requirements.

B. ANSI Z358.1; pedestal mounted, stainless steel bowl with elbow, 1-1/4 inch stainless steel pipe pedestal with floor flange, instant action stay open valve actuated by push flag or foot pedal, twin spray heads with face spray ring, dust cover assembly, wall mount bracket, and tailpiece and chrome plated brass P-trap. Furnish universal emergency sign.

C. Furnish emergency type mixing valve with cold water bypass, stainless steel valve box and temperature gauge.

2.10 EMERGENCY COMBINATION SHOWER WITH EYE AND FACE WASH

A. Manufacturers:
1. Bradley Corp.
2. Chicago Faucet Co.
3. Encon Safety Products
4. Haws Drinking Faucet Co.
5. Guardian
6. Speakman
7. Substitutions: Section 01 60 00 - Product Requirements.

B. Shower: ANSI Z358.1; free standing, self- cleaning, non-clogging stainless steel drench shower head, instant action stay open valve actuated by rigid stainless steel pull rod.

C. Eyewash: ANSI Z358.1; stainless steel bowl with elbow, 1-1/4 inch stainless steel pipe pedestal with floor flange, instant action stay open valve actuated by push flag , twin spray heads with face spray ring, dust cover assembly, wall mount bracket, and tailpiece and chrome plated brass P-trap.

D. Supply and Waste Piping: 1 inch 1-1/4 inch galvanized steel stainless steel pipe pedestal with floor flange.

E. Furnish universal emergency sign.

F. Furnish emergency type mixing valve with cold water bypass, stainless steel valve box and temperature gauge.

2.11 LAVATORY INSULATION KIT

A. Manufacturers:
1. McGuire
2. Truebro
3. Plumerex
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Where Lavatories are noted to be insulated for ADA compliance, furnish the following: Safety Covers conforming to ANSI A177.1 and consisting of insulation kit of molded closed cell vinyl construction, 3/16 inch thick, white gray color, for insulating tailpiece, P-trap, valves, and supply piping. Furnish with weep hole and angle valve access covers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify walls and floor finishes are prepared and ready for installation of fixtures.

C. Verify electric power is available and of correct characteristics.

D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid or flexible supplies to fixtures with loose key screwdriver stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports wall carriers and bolts.

E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 90 00, color to match fixture.

F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

G. For ADA accessible water closets, install flush valve with handle to wide side of stall.

H. For faucets rated for less than 2.2 gpm, hot water recirculation shall connect to within eight feet of faucet and shall be provided with a balancing valve.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.5 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean plumbing fixtures and equipment.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Do not permit use of fixtures before final acceptance.

3.8 SCHEDULES

A. Fixture Rough-In:

Fixture	Hot inches	Cold inches	Waste inches	Vent inches
Water Closet (Flush Valve):		1	4	2
Urinal (Flush Valve):		3/4	2	1-1/2
Lavatory:	1/2	1/2	1-1/2	1-1/4
Sink:	1/2	1/2	1-1/2	1-1/4
Service Sink:	1/2	1/2	2	1-1/2
Service Sink:	1/2	1/2	3	1-1/2
Drinking Fountain:		1/2	1-1/4	1-1/4
Shower:	1/2	1/2	1-1/2	1-1/4

END OF SECTION

SECTION 230400 - GENERAL CONDITIONS FOR MECHANICAL TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This section applies to certain sections of Division 26, "Electrical," and this section applies to all sections of Division 23, "Mechanical" of this project specification unless specified otherwise in the individual sections.

1.2 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

1.3 INTENT

A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.

B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.

C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.

D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

1.4 DEFINITIONS

A. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.

B. “Approved equal” mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.

C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

D. “Finished” refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.

E. “Furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.

F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

G. “Install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.

H. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.

I. “Provide” shall mean furnish (or supply) and install as necessary.

J. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

K. Remove: The term “remove” means “ to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”

L. Special Warranties: The term “Special Warranties” are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

M. Standard Product Warranties: The term “Standard Product Warranties” are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

N. “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Plumbing Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.

O. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."

P. “Wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

1.5 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.

D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.6 SURVEYS AND MEASUREMENTS

A. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

B. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

1.7 CODES AND STANDARDS

A. Reference Standard Compliance
   1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
   2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

B. The Following Codes and Standards listed below apply to all mechanical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:
Connecticut State Building Code - Connecticut Supplement
The International Building Code
The International Mechanical Code
The International Plumbing Code
The International Energy Conservation Code
The National Electrical Code
NFPA 101 Life Safety
ASHRAE 90.1

C. The following Standards shall be used where referenced by the following abbreviations:

AABC	Associated Air Balance Council
ACGIH	American Conference of Governmental Industrial Hygienists
ADC	Air Diffusion Council
AGA	American Gas Association
AIA	American Institute of Architects
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CGA	Compressed Gas Association
CSA	Canadian Standards Association
CISPI	Cast Iron Soil Pipe Institute
EJMA	Expansion Joint Manufacturing Association
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
HIS	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	Insurance Services Office
MCAA	Mechanical Contractors Association of America
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NOFI	National Oil Fuel Institute
NSC	National Safety Council
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SBI	Steel Boiler Industry (Division of Hydronics Institute)
SMACNA	Sheet Metal and Air Conditioning Contractors National Association

STI	Steel Tank Institute
UL	Underwriters' Laboratories

D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.

E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.8 PERMITS AND FEES

A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.9 EQUIPMENT EQUIVALENTS AND SUBSTITUTIONS

A. In these Contract Documents, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. These describe the basis of design and approved equivalents. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation without consideration of any or all costs associated but not limited to (structural, mechanical, or electrical feeder, breaker, or transformer requirements). The Contractor acknowledges that not all requirements are shown for either alternate acceptable manufacturers listed or those alternates requiring a request for substitution and it is their responsibility to coordinate all requirements necessary to accommodate any change from the basis of design listed or scheduled. The contractor is required to submit any and all costs (including costs associated or required by all trades) along with performance differences as part of their request for substitution. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.

B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineers review.

C. Where two or more names are given as approved manufacturers of equivalents, the Contractor must use the specified item or one of the named equivalents which still must meet all of the performance characteristics of the basis of design make and model. Where one name only is used and is followed by the words "or approved equal", the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.

D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the basis of design scheduled equipment or materials as hereinafter specified or shown on the drawings, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution, equivalent or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be

included in the Base Bid with manufacturer's equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.

E. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Engineers/Architects of Record at the expense of the Contractor and at no additional cost to the Owner.

F. Where such accepted deviation resulting from using an approved equivalent or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, after acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the deviation.

G. Equipment, material or devices submitted for review as an "equivalent" shall meet the following requirements:
   1. The equivalent shall have the same construction features such as, but not limited to:
      a. Material thickness, gauge, weight, density, etc.
      b. Welded, riveted, bolted, etc., construction
      c. Finish, undercoating, corrosion protection
   2. The equivalent shall perform with the same or better operating efficiency.
   3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
   4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.
   5. Where such equivalents requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, with the acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the equivalent change from the basis of design shown on the drawings or within the specifications.

H. Equipment, material or devices submitted for review as a "substitution" shall meet the following requirements:
   1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
   2. Submit three (3) copies of each request for substitution for consideration.
   3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
      a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
      b. Samples, where applicable or requested.

c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.

d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.

e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.

f. Cost information, including a proposal of the net change, if any in the Contract Sum.

g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.

h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.

i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.

1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.

2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.

3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.10 SUBMITTAL PROCEDURES

A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
2. If an intermediate submittal is necessary, process the same as the initial submittal.
3. Allow two weeks for reprocessing each submittal.
4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
1. Include the following information on the label for processing and recording action taken.
   a. Project name.
   b. Date.
   c. Name and address of Engineer.
   d. Name and address of Contractor.
   e. Name and address of subcontractor.
   f. Name and address of supplier.
   g. Name of manufacturer.
   h. Number, title and paragraph of appropriate Specification Section.
   i. Drawing number and detail references, as appropriate.

E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.

G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked to indicate the action taken.

1.11 SHOP DRAWINGS

A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or

copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Mechanical Contract. Refer to Division 1 for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.

C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, fire protection, etc.

E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.

G. "No Exception Taken" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.

H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.

I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.

J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.

K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

L. Prepare sheetmetal and sprinkler shop drawings drawn in the latest AutoCAD version to a minimum scale of 1/4” = 1’- 0”. Final approved drawings shall be turned over to the Owner on floppy disk or CD Rom.

1.12 COORDINATION DRAWINGS

A. Prepare coordination drawings drawn in the latest AutoCAD version in accordance with Division 1 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
   a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
   b. Equipment connections and support details.
   c. Exterior wall and foundation penetrations.
   d. Fire-rated wall and floor penetrations.
   e. Sizes and locations of required concrete pads and bases.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

E. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.

F. Work shall not be performed until coordination drawings have been approved by the architect and engineer.

G. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. The cost for these floor plans is a lump sum fee of $ 1,000.00. If the Contractor elects to obtain the Engineers electronic files an Electronic Drawing File Release Form must be submitted with payment. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the Electronic Drawing File Release Form, and payment, the Engineer will provide copies of the electronic files for the Contractor’s use. A copy of the Electronic Drawing File Release Form is appended to the end of this specification section

1.13 COORDINATION WITH OTHER DIVISIONS

A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors,

especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.

B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.

C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.

D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

1.14 WORKMANSHIP

A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

E. All labor for installation of mechanical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.15 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.

B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.16 TEMPORARY UTILITIES

A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

C. First Aid Supplies: Comply with governing regulations.

D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.

E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.

F. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.

G. Temporary Heat-Cool-Dehumidification: Provide temporary services required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate temporary services to produce the ambient condition required and minimize consumption of energy. The building’s permanent HVAC systems shall not be used for these purposes.

H. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

I. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when 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 the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.17 BUILDING FLUSH-OUT

A. Building flush-out shall begin after construction ends and finishes are installed but prior to building occupancy. Prior to building flush-out, HVAC systems shall be balanced per Specification Section 23 05 93. Flush-out shall not occur until contractor receives permission to proceed from the Owner or Owner's representative. Flush-out shall continue during the first weeks of occupancy as scheduled below.

B. Building flush-out procedures shall include continuously operating all the building's new ventilation systems at maximum design outside air flow rates. For constant volume HVAC systems, ventilation systems shall operate at maximum design supply air flow rates. For VAV systems, supply air flow shall be allowed to vary to maintain space temperatures. HVAC systems shall be set to maintain internal space temperatures at minimum 60°F and maximum 78°F and relative humidity at maximum 60% RH.

C. Building flush-out prior to occupancy: HVAC systems shall operate continuously, 24 hours per day, for a minimum period of 12 days. Commissioning and testing of the HVAC systems' temperature controls shall be allowed during this time frame.

D. Building flush-out at start of occupancy: HVAC systems shall operate continuously, 24 hours per day, for a minimum period of 40 days.

1.18 PROTECTION OF MATERIALS AND EQUIPMENT

A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.

B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.

D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.19 ADJUSTING AND TESTING

A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.

B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing, that the equipment was installed according to manufacturers recommendations and is operating as intended by the manufacturer.

1.20 CLEANING

A. The Contractor shall thoroughly clean and flush all piping, ducts and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.

B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

C. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.

D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.

E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
   1. Remove labels that are not permanent labels.
   2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
   3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
   4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.

F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.

G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.21 OPERATING AND MAINTENANCE

A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.

C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.

D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; air conditioning equipment, controls, air handling equipment, compressors, boilers etc. These letters shall be bound into the operating and maintenance books.

E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

F. Demonstration shall be professionally recorded with two (2) copies of the demonstration turned over to the Owner.

1.22 OPERATING AND MAINTENANCE MANUALS

A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.

B. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing and operating instructions including lubrication charts and schedules.
5. Emergency and safety instructions.
6. Spare parts list.

7. Copies of warranties.
8. Wiring diagrams.
9. Recommended "turn around" cycles.
10. Inspection procedures.
11. Approved Shop Drawings and Product Data.
12. Equipment Start-up Reports.
13. Temperature control diagrams and written sequences of operations.
14. Balance reports.

C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.

D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.23 ACCEPTANCES

A. The equipment, materials, workmanship, design and arrangement of all work installed under the Mechanical Sections shall be subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, the Mechanical Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Mechanical Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.

C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner’s representative.

D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Mechanical Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.

F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.24 RECORD DRAWINGS

A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:
1. Dimensional change
2. Revision to drawing detail
3. Location and depth of underground utility
4. Revision to pipe routing
5. Revision to electrical circuitry
6. Actual equipment location
7. Duct size and routing
8. Location of concealed internal utility
9. Changes made by Change Order
10. Details not on original Contract Drawing
11. Information on concealed elements which would be difficult to identify or measure later

C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.

D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.

E. Note related Change Order numbers where applicable.

F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

G. These shall be clearly marked for Record Drawings on a clean set of reproducible drawings at the completion of the work and turned over to the Owner.

1.25 WARRANTIES AND BONDS

A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
1. General close-out requirements included in Division 1.
2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions-2 through -26.
3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor

does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.26 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
   1. Refer to individual Sections of Divisions-2 through -26 for specific content requirements, and particular requirements for submittal of special warranties.

J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.

1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the 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 the installer.
2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.27 GUARANTEES

A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.

B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

1.28 PROJECT CLOSE-OUT

A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents in accordance with Division 1.

B. Deliver tools, spare parts, extra stock, and similar items.

C. Complete start-up testing of systems, including measuring and documenting all required startup checklist requirements documented in installation and maintenance instructions by the equipment manufacturer, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

D. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

E. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued.

1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.

2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION

Electronic Drawing File Release Form

DELIVERY OF FILES FOR: _____

Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ _____

Client's Signature Date

_____

Company - Title

_____ _____

Architects' Signature Date

_____

Firm - Title

_____ _____

Owner's Signature Date

_____

Company - Title

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section includes single- and three-phase motors for application on equipment provided under other sections.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
3. Section 26 05 53 - Identification for Electrical Systems.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.

C. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

A. Manufacturers:
1. Cooper Industries Inc.
2. Eaton Corp.
3. General Electric Co.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Motors 3/4 hp and Larger: Three-phase motor as specified below.

C. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.

D. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
1. Voltage: As indicated on Drawings.
2. Service Factor: 1.15.
3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
5. Insulation System: NEMA Class F.
6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
9. Sound Power Levels: Conform to NEMA MG 1.

E. Single Phase Motors:
1. Electronically commutated where available, otherwise use permanent split-capacitor type or split-phase start/capacitor run or capacitor start/capacitor run motor.
2. Voltage: As indicated on drawings, single phase, 60 Hz.

F. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 SOURCE QUALITY CONTROL

A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

B. Install engraved plastic nameplates in accordance with Section 26 05 53.

C. Ground and bond motors in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Flexible pipe connectors.
2. Expansion joints.
3. Expansion compensators.
4. Pipe alignment guides.
5. Swivel joints.
6. Pipe anchors.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product and installation requirements for piping hangers and supports.
3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
4. Section 23 21 13 - Hydronic Piping: Product and installation requirements for piping used in hydronic heating and cooling systems.
5. Section 23 23 00 - Refrigerant Piping: Product and installation requirements for piping used in refrigeration systems.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.5 - Refrigeration Piping.
2. ASME B31.9 - Building Services Piping.
3. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

1.3 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Expansion Compensation Design Criteria:
1. Installation Temperature: 50 degrees F.
2. Hot Water Heating System Temperature: 210 degrees F.
3. Safety Factor: 30 percent.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered professional engineer.

C. Product Data:
1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
a. On Victaulic installations, provide specific locations and style number of intended flexible couplings to be used in lieu of each flexible connector
2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

D. Design Data: Indicate criteria and show calculations. Submit calculations sealed by a registered professional engineer.]

E. Manufacturer's Installation Instructions: Submit special procedures.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX and AWS D1.1.

H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

C. Operation and Maintenance Data: Submit adjustment instructions.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.5 and ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Connecticut.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer’s standard, no less than one year from date of Owner’s acceptance.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:
1. Mason
2. Metraflex
3. Vibration Elimination
4. Victaulic (grooved systems)
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Steel Piping:
1. Inner Hose: Carbon Steel.
2. Exterior Sleeve: Double braided stainless steel.
3. Pressure Rating: 125 psig WSP and 450 degrees F.
4. Joint: As specified for pipe joints.
5. Size: Use pipe-sized units.
6. Maximum offset: 3/4 inch on each side of installed center line.

C. Copper Piping:
1. Inner Hose: Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: 125 psig WSP and 450 degrees F.
4. Joint: As specified for pipe joints.
5. Size: Use pipe sized units.
6. Maximum offset: 3/4 inch on each side of installed center line.

D. On Victaulic grooved installations, three (3) flexible couplings may be used in lieu of each flexible connector at major equipment connections. Couplings shall be placed in proximity of the vibrating source per manufacturers recommendations.

2.2 EXPANSION JOINTS

A. Manufacturers:
1. Mason
2. Metraflex
3. Vibration Elimination
4. Victaulic (grooved systems)
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Stainless Steel Bellows Type:
1. Pressure Rating: 125 psig WSP and 400 degrees F.
2. Maximum Compression: 1-3/4 inch.
3. Maximum Extension: 1/4 inch.
4. Joint: As specified for pipe joints.
5. Size: Use pipe sized units.
6. Application: Steel piping 3 inch and smaller.

C. External Ring Controlled Stainless Steel Bellows Type:
1. Pressure Rating: 125 psig WSP and 400 degrees F.
2. Maximum Compression: 15/16 inch.
3. Maximum Extension: 5/16 inch.
4. Maximum Offset: 1/8 inch.
5. Joint: Flanged.
6. Size: Use pipe sized units.
7. Accessories: Internal flow liner.
8. Application: Steel piping 3 inch and larger.

D. Two-ply Bronze Bellows Type:
1. Construction: Bronze with anti-torque device, limit stops, internal guides.
2. Pressure Rating: 125 psig WSP and 400 degrees F.
3. Maximum Compression: 1-3/4 inch].
4. Maximum Extension: 1/4 inch.
5. Joint: As specified for pipe joints.
6. Size: Use pipe sized units.
7. Application: Copper piping.

E. Copper with Packed Sliding Sleeve:
1. Maximum Temperature: 250 degrees F.
2. Joint: As specified for pipe joints.
3. Size: Use pipe sized units.
4. Copper or steel piping 2 inches and larger.
5. Application: Copper or steel piping 2 inch and larger.

F. Grooved-End Expansion Joints for Steel Piping Systems:
1. Maximum Temperature: 230F
2. Joint: Grooved
3. Size: 2 inches and larger
4. Style: Slip type or Combination nipples/couplings

5. Application: Steel piping 2 inches and larger; water service

2.3 ACCESSORIES

A. Manufacturers:
1. Mason
2. Metraflex
3. Vibration Elimination
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

C. Swivel Joints: Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install Work in accordance with ASME B31.5 and ASME B31.9.

B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Refer to Section 21 05 48. Provide line size flexible connectors.

C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.

E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required and as indicated on Drawings. Refer to Section 22 05 29 for pipe hanger installation requirements.

F. Provide grooved piping systems with minimum of three (3) flexible couplings instead of each flexible connector supported by vibration isolation.

G. Provide expansion loops as indicated on Drawings. On grooved piping installations, utilize only flexible couplings on all four (4) corners of the loop. Rigid couplings shall not be permitted on any loop.

3.2 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers’ field services.

B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Gate valves.
2. Globe valves.
3. Ball valves.
4. Butterfly valves.
5. Check valves.

B. Related Sections:
1. Section 22 11 23 - Facility Natural-Gas Piping: Product and installation requirements for piping, piping specialties, and equipment used in natural gas piping systems.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product and installation requirements for pipe hangers and supports.
4. Section 23 07 00 - HVAC Insulation: Product and installation requirements for insulation for valves.
5. Section 23 21 13 - Hydronic Piping: Product and installation requirements for piping used in hydronic piping systems.
6. Section 23 21 16 - Hydronic Piping Specialties: Product and installation requirements for piping specialties used in hydronic piping systems.
7. Section 23 23 00 - Refrigerant Piping: Product and installation requirements for valves and piping specialties used in refrigeration systems.

1.2 REFERENCES

A. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 67 - Butterfly Valves.
2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
4. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
5. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of valves.

C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum three years experience.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Manufacturer’s standard, no less than one year from date of Owner’s acceptance.

1.9 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.

B. Furnish two packing kits for each size valve.

PART 2 PRODUCTS

2.1 GATE VALVES

A. Manufacturers:
1. Crane Valve, North America
2. Victaulic

3. Milwaukee Valve Company
4. Watts
5. Substitutions: Section 01 60 00 - Product Requirements.

B. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, union bonnet, non-rising stem, hand-wheel, inside screw with back-seating stem, solid wedge disc, alloy seat rings, solder or threaded ends.

C. 2-1/2 inches and Larger: MSS SP 70, Class 125, cast iron body, bronze trim, bolted bonnet, non-rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.2 GLOBE VALVES

A. Manufacturers:
1. Crane Valve, North America
2. Milwaukee Valve Company
3. Watts
4. Substitutions: Section 01 60 00 - Product Requirements.

B. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, union bonnet, hand wheel, Buna-N composition disc, solder or threaded ends.

C. 2-1/2 inches and Larger: MSS SP 85, Class 125, cast iron body, bronze trim, hand wheel, outside screw and yoke, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.3 BALL VALVES

A. Manufacturers:
1. Crane Valve, North America
2. Milwaukee Valve Company
3. Watts
4. Substitutions: Section 01 60 00 - Product Requirements.

B. 2 inches and Smaller: MSS SP 110, Class 150, bronze, three piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, solder or threaded ends, locking lever handle with balancing stops.

2.4 BUTTERFLY VALVES

A. Manufacturers:
1. Crane Valve, North America
2. Milwaukee Valve Company
3. Victaulic
4. Substitutions: Section 01 60 00 - Product Requirements.

B. 2-1/2 inches and Larger: MSS SP 67, Class 150.
1. Body: Cast or ductile iron, wafer, lug or grooved ends, stainless steel stem, extended neck.
2. Disc: Nickel-plated ductile iron.

3. Seat: Resilient replaceable EPDM.
4. Handle and Operator: Infinite position lever handle with memory stop Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

C. 2-1/2 inches and Larger. Meets or exceeds MSS SP 67, 300 PSI. Ductile iron PPS or black enamel coated body, grooved ends, ductile iron offset disc with PPS or electroless nickel coating, resilient replaceable EPDM. Handle and Operator: Infinite position lever handle with memory stop. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

D. 2-1/2 inches through 6 inches: Meets or exceeds MSS SP 67, bronze body with copper tube dimensioned grooved ends, flouroelastomer coating (32F to 250F) bonded to the ductile iron disc core, integrally cast stem, lever handle, gear operator, or power actuator. Handle and Operator: Infinite position lever handle with memory stop. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.]

2.5 CHECK VALVES

A. Horizontal Swing Check Valves:
1. Manufacturers:
   a. Crane Valve, North America
   b. Milwaukee Valve Company
   c. Victaulic
   d. Watts
   e. Substitutions: Section 01 60 00 - Product Requirements.
2. 2 inches and Smaller: MSS SP 80, Class 150, bronze body and cap, bronze seat, Buna-N disc, solder or threaded ends.
3. 2-1/2 inches and Larger: MSS SP 71, Class 125, cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.

B. Spring Loaded Check Valves:
1. Manufacturers:
   a. Crane Valve, North America
   b. Milwaukee Valve Company
   c. Victaulic
   d. Watts
   e. Substitutions: Section 01 60 00 - Product Requirements.
2. 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded ends.
3. 2-1/2 inches and Larger: MSS SP 71, Class 125, globe style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.
4. 2-1/2 inches through 12 inches: 300 psi CWP, ductile iron body, aluminum bronze or elastomer encapsulated ductile iron disc, stainless steel spring and shaft, PPS coated or welded-in nickel seat, grooved ends. Venturi taps located on both sides may be provided for flow measurement accuracy.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

D. Install valves with clearance for installation of insulation and allowing access.

E. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.

F. Refer to Section 23 05 29 for pipe hangers.

G. Refer to Section 23 07 00 for insulation requirements for valves.

H. For installation of valves in hot water piping systems refer to Section 23 22 13.

3.3 VALVE APPLICATIONS

A. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.

B. Install ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install globe valves for throttling, bypass, or manual flow control services.

D. Install spring loaded check valves on discharge of water pumps.

E. Install lug end butterfly valves adjacent to equipment when functioning to isolate equipment.

END OF SECTION

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Equipment bases and supports.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
3. Section 22 11 23 - Facility Natural-Gas Piping: Execution requirements for placement of hangers and supports specified by this section.
4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and execution requirements for vibration isolators.
5. Section 23 21 13 - Hydronic Piping: Execution requirements for placement of hangers and supports specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.5 - Refrigeration Piping.
2. ASME B31.9 - Building Services Piping.

B. ASTM International:
1. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Submit calculations sealed by a registered professional engineer.]

E. Manufacturer's Installation Instructions:
1. Hangers and Supports: Submit special procedures and assembly of components.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer's standard, no less than one year from date of Owner's acceptance.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
1. Nibco
2. Empire
3. Flex-Weld, Inc.
4. Glope Pipe Hanger Products Inc.
5. Michigan Hanger Co.
6. Superior Valve Co.
7. Substitutions: Section 01 60 00 - Product Requirements.

B. Hydronic Piping:
1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 5 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, carbon steel ring.

C. Refrigerant Piping:
1. Conform to ASME B31.5, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Vertical Support: Steel riser clamp.

7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
8. Copper Pipe Support: Copper-plated carbon-steel ring.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

A. Manufacturers:
1. Thunderline Link Seal
2. Fernco
3. BWM
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:
1. Waterproofing: 5 lb./sq. ft sheet lead.
2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

E. Sealant: Acrylic; refer to Section 07 90 00].

2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation

3. Fernco
4. BWM
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division
4. Unistrut Corp.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Obtain permission from Architect/Engineer before using powder-actuated anchors.

B. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.5, ASME 31.9, ASTM F708, MSS SP 58, MSS SP 69 and MSS SP 89.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support vertical piping at every floor.

G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide copper plated hangers and supports for copper piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

K. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 23 07 00 Provide supplemental angles, channels and formed steel supports to support piping, ductwork, equipment, etc. from building's structure. Piping, ductwork, equipment, etc. shall not be supported from the roof deck.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

B. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

C. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 23 05 48.

3.6 INSTALLATION - FLASHING

A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

3.7 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install chrome plated steel escutcheons at finished surfaces.

3.8 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

3.10 SCHEDULES

A. Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4
8	16	19	3/4	3/4
10	18	22	3/4	7/8
12	19	23	3/4	7/8

END OF SECTION

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 INTENT

A. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.

B. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.

C. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.

D. All such systems must be installed in strict accordance with seismic codes, component manufacturer's recommendations and building construction standards. Whenever a conflict occurs between the manufacturer's recommendations or construction standards, the most stringent shall apply.

E. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements).

F. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.2 SUMMARY

A. Section Includes:
1. Certification of seismic restraint designs and installation supervision.
2. Certification of seismic attachment of housekeeping pads.
3. NOTE: For all mechanical and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included.
4. Seismic restraint products
    a. Vibration isolation elements.
    b. Equipment isolation bases.
    c. Piping flexible connections.
    d. Seismic restraints for isolated and non-isolated mechanical and electrical items.
5. Acoustic reduction products
    a. Duct silencers.

B. Related Sections:
1. Section 07 90 00 - Joint Protection: Product requirements for joint sealers specified for placement by this section.
2. Section 23 04 00 – General Conditions for Mechanical Trades

3. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product requirements for anchors and piping expansion compensation.
4. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports.
5. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this section.
6. Section 23 33 00 - Air Duct Accessories: Product requirements for both solid and flexible duct connectors for duct silencers specified for placement by this section.

1.3 REFERENCES

A. Sheet Metal and Air Conditioning Contractors':
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.4 RELATED WORK

A. Housekeeping Pads
   1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
   2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel
   1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.

C. Attachments
   1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.5 SEISMIC FORCE LEVELS

A. Installations shall be designed to safely accept external forces determined in accordance with the International Building Code – 2012 in any direction for all rigidly supported equipment without failure and permanent displacement of the equipment. Seismic restraints shall not short circuit vibration isolation systems or transmit objectionable vibration or noise.

1.6 DEFINITIONS

A. Life Safety Systems:
   1. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flow paths to fire protection and/or emergency lighting systems.
   2. All medical and life support systems.
   3. Fresh air relief systems on emergency control sequence including air handlers, conduit, duct, dampers, etc.

B. Positive Attachment:
   1. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, electrical conduit, bus duct, or cable trays, or any other equipment are not acceptable on this project as seismic anchor points.

C. Transverse Bracing:
   1. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

D. Longitudinal Bracing:
   1. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

E. Failure
   1. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" (3mm) and/or horizontal permanent deformation greater that 1/4" (6mm).

1.7 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings:
   1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
   2. Provide Drawings showing methods of suspension and support guides for conduit, piping, ductwork and ceiling hung equipment.
   3. Record actual locations and installation of vibration isolators and seismic restraints including attachment points.
   4. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
   5. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
   6. Drawings showing methods for isolation of conduits, pipes and ductwork penetrating walls and floor slabs.
   7. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, for each piece of equipment and/or pipe and duct locations.

C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

D. Seismic Certification and Analysis:
   1. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.

2. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in section 1.06 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

E. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.

F. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.

G. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

H. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.8 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of silencers. Record actual locations of hangers including attachment points.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

C. Design application of seismic snubbers under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Connecticut.

1.10 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 CONTRACTOR’S RESPONSIBILITIES

A. Contractor shall have the following responsibilities:
1. Determine vibration isolation and seismic restraint sizes and locations per specifications.
2. Provide and install isolation systems and seismic restraints as scheduled or specified.
3. Guarantee specified isolation system deflection.

4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
5. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
6. Substitution of "Internally Isolated" mechanical equipment in lieu of the specified isolation of this section is acceptable

1.13 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer's standard, no less than one year from date of Owner's acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Mason Industries Inc. models listed below.

B. Other approved manufacturers providing equivalent products include:
1. Vibration Eliminator Co.
2. Vibro-Acoustics Ltd.

2.2 PRODUCT DESCRIPTIONS

A. Vibration Isolators and Seismic Restraint Specifications – Products used are listed in table at the end of this section.
1. Specification 1 - Neoprene Pad
a. Two layers of 3/4" (19mm) thick neoprene pad consisting of 2" (50mm) square waffle modules separated horizontally by a 16 (1.5mm) gauge galvanized shim. Load distribution plates shall be used as required.
b. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.
2. Specification 2 - Bridge-Bearing Neoprene Mountings
a. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" (5mm) and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications.
b. Mountings shall be Type BR as manufactured by Mason Industries, Inc.
3. Specification 3 – Bushing Assemblies
a. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing

assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality.

b. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.

4. Specification 4 - Neoprene Bushing
   a. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact.
   b. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
5. Specification 5 – Spring Isolators
   a. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6mm) neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.
   b. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.
6. Specification 6 – Restrained Spring Mountings
   a. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" (12mm) shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces.
   b. Mountings shall be SLR as manufactured by Mason Industries, Inc.
7. Specification 7 – Spring Mountings
   a. Spring mountings as in specification 5 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4" (6mm) travel in all directions before contacting the resilient snubbing collars.
   b. Mountings shall be SSLFH as manufactured by Mason Industries, Inc.
8. Specification 8 – Air Springs
   a. Air Springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8" (3mm). Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician.
   b. Air Springs shall be Type MT and leveling valves Type LV as manufactured by Mason Industries, Inc.
9. Specification 9 – Restrained Air Springs
   a. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent

air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" (12mm) shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces.

b. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc.

10. Specification 10 – Hangers
    a. Hangers shall consist of rigid steel frames containing minimum 1 1/4" (32mm) thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30o arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30o capability.
    b. Hangers shall be type 30N as manufactured by Mason Industries, Inc.
11. Specification 11 – Hangers
    a. Hangers shall be as described in 10, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30o capability.
    b. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
12. Specification 12 - Seismic Cable Restraints
    a. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cables must be prestretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges.
    b. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.
13. Specification 13 – Seismic Solid Braces
    a. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment.
    b. Solid seismic brace assemblies shall be type SSB as manufactured by Mason Industries, Inc.
14. Specification 14 – Rod Clamp Assemblies
    a. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable.

b. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.

15. Specification 15 – Clevis Hanger Cross Brace
    a. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt.
    b. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
16. Specification 16 - All-Directional Seismic Snubbers – Small Neoprene
    a. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4" (6mm) thick. Rated loadings shall not exceed 1000 psi (.7kg/mm2). A minimum air gap of 1/8" (3mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated.
    b. Snubber shall be Type Z-1225 as manufactured by Mason Industries, Inc.
17. Specification 17 - All-Directional Seismic Snubbers – Large Rubber
    a. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" (19mm) thick. Rated loadings shall not exceed 1000 psi (.7kg/mm2). Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" (3mm) nor more that 1/4" (6mm). Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" (9mm) deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" (12mm) deflection in the x, y and z planes.
    b. Snubbers shall be series Z-1011 as manufactured by Mason Industries, Inc.
18. Specification 18 – Stud Wedges
    a. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads.
    b. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.
19. Specification 19 – Female Wedge Anchors
    a. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying to its allowable loads.
    b. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.
20. Specification 20 – Equipment Bases
    a. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump

bases for split case pump shall include supports for suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14" (350mm) provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1" (25mm).

b. Bases shall be type WF as manufactured by Mason Industries, Inc.

21. Specification 21 – Inertia Foundations
    a. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6" (150mm). The base depth need not exceed 12" (300mm) unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" (12mm) bars welded in place on 6" (150mm) centers running both ways in a layer 1 1/2" (38mm) above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" (25mm) clearance below the base. Wooden formed bases leaving a concrete rather then a steel finish are not acceptable.
    b. Base shall be type BMK or K as manufactured by Mason Industries, Inc.
22. Specification 22 – Curbs
    a. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind and seismic forces. All directional neoprene snubber bushings shall be a minimum of 1/4" (6mm) thick. Steel springs shall be laterally stable and rest on 1/4" (6mm) thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2" (50mm) of insulation. The roof curbs shall be built to seismically contain the rooftop unit. The unit must be solidly fastened to the top floating rail, and the lower Z section anchored to the roof structure.
    b. Curb shall be type RSC as manufactured by Mason Industries, Inc.
23. Specification 23 – Expansion Joints
    a. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Kevlar7 tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" (50mm) and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16" (400mm) to 24" (600mm) may be single sphere. Sizes 3/4" (19mm) to 1 2" (38mm) may have threaded two piece bolted flange assemblies, one sphere and cable retention. Connectors shall be rated at 250 psi (1.72MPa) up to 170o F (77oC) with a uniform drop in allowable pressure to 215 psi (1.48MPa)at 250o F (121oC) in sizes

through 14"(350mm). 16" (400mm) through 24" (600mm) single sphere minimum ratings are 180 psi (1.24MPa) at 170o F (77oC) and 150 psi (1.03 MPa) at 250o F (121oC). Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.

b. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods. If control rods are used, they must have 2" (12mm) thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi (.7 kg/mm2) maximum on the washer area.

c. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves.

d. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.

24. Specification 24 – Flexible Stainless Steel Hoses

a. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" (75mm) and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

Flanged		Male Nipples	
3 x 14	10 x 26	1/2 x 9	1 1/2 x 13
4 x 15	12 x 28	3/4 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2 1/2 x 18
6 x 20	16 x 32	1 1/4 x 12	
8 x 22			

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

c. Hoses shall be type BSS as manufactured by Mason Industries, Inc.

25. Specification 25 - All-Directional Acoustical Pipe Anchor

a. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" (12mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi (.35 kg/mm2) and the design shall be balanced for equal resistance in any direction.

b. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.

26. Specification 26 – Pipe Guides

a. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (12mm) thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable

to allow for selection of pipe movement. Guides shall be capable of + 1 5/8" (41mm) motion, or to meet location requirements.

b. Pipe guides shall be type VSG as manufactured by Mason Industries, Inc.

27. Specification 27 - Split Wall Seals
    a. Split Wall Seals consist of two bolted pipe halves with minimum 3/4" (19mm) thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of l" (25mm) past either face of the wall. Where temperatures exceed 240o F (115oC), 10# (4.5kg) density fiberglass may be used in lieu of the sponge.
    b. Seals shall be Type SWS as manufactured by Mason Industries, Inc.
28. Specification 28 - Horizontal Thrust Restraint
    a. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" (6mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the duct work or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit.
    b. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc.

B. Table for Project: the list of Product Specification Type 1 through Type 28 to be used for project is located in at the end of the EXECUTION section.

2.3 DUCT SILENCERS

A. Manufacturers:
1. Vibro-Acoustic.
2. Price.
3. Ruskin Sound Control.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Configuration: Rectangular with lined splitters with radius nose and contoured tails, dimensions matching the attached ductwork.

D. Materials:
1. Outer Casing: Minimum 20 gage thick galvanized steel stiffened with welded seams, 2 inch long, 11 gage slip joints on both ends.
2. Inner Casing and Splitters: Minimum 24 gage thick perforated galvanized steel.
3. Fill: Glass fiber or mineral wool of minimum 3 lb/cu ft density.
4. Fill Liner: 1 mil Mylar film.

E. Rating:
1. Refer to schedules on Construction Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify equipment, ductwork and piping is installed before work in this section is started.

3.2 INSTALLATION OF VIBRATION ISOLATORS

A. Vibration isolators and seismic restraint systems shall control excessive noise and vibration in the buildings due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork, or conduit. The installation of all vibration isolators and seismic restraint units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.

B. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

C. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

E. The contractor shall not install any equipment, piping, duct or conduit that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

F. Coordinate work with other trades to avoid rigid contact with the building.

G. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractors expense.

H. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractors expense.

I. Correct, at no additional cost, all installations that are deemed defective in workmanship and materials at the contractor’s expense.

J. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:

1. Flanges of structural beams.
2. Upper truss cords in bar joist construction.
3. Cast in place inserts or wedge type drill-in concrete anchors.

K. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

L. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.

M. At locations where specification 12 or 13 restraints are located, the support rods must be braced when necessary to accept compressive loads with specification 14 braces.

N. At all locations where specification 12 or 13 restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with specification type 15 braces.

O. Drill-in concrete anchors for ceiling and wall installation shall be specification type 18, and specification type 19 female wedge type for floor mounted equipment.

P. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project. Each fan and motor assembly shall be supported on a single structural steel frame.

Q. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed specification 23 capabilities.

R. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide specification 27 wall seals.

S. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be specification type 28 (see selection guide).

T. Install isolation for motor driven equipment.

U. Bases:
1. Set steel bases for 1 inch clearance between housekeeping pad and base.
2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.

V. Adjust equipment level and install spring hangers without binding. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions. Locate isolation hangers as near to the overhead support structure as possible.

W. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

X. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.

Y. Support piping connections to isolated equipment resiliently as follows:
1. Up to 4 inch Diameter: First three points of support.
2. 5 to 8 inch Diameter: First four points of support.
3. 10 inch Diameter and Over: First six points of support.
4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.3 INSTALLATION OF ACOUSTIC PRODUCTS

A. Support duct silencers independent of ductwork. Refer to Section 23 33 00.

3.4 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect isolated equipment after installation and submit report. Include static deflections.

C. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

3.5 Equipment Isolation Schedule: SCHEDULES

	ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR SOLID CONCRETE FLOORS 4" AND THICKER (NOTE 7)									
	Ground Supported Slab or Basement		20' Floor Span Possible Floor Defl. – 0.67"		30' Floor Span Possible Floor Defl. – 1.0"		40' Floor Span Possible Floor Defl. – 1.33"		50' Floor Span Possible Floor Defl. – 1.67"	
SPECIFICATION SELECTION GUIDE	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.
REFRIG. MACHINES										
Centrifugal Chillers or Heat Pumps										
Cooler Condenser Mounted Hermetic Compressors	2-20-23	0.35	6-20-23	0.75	6-20-23	1.5	6-23	1.5	6-20-23	2.5
Cooler Condenser Alongside Hermetic Compressor	2-23	0.35	6-23	0.75	6-23	1.5	6-23	1.5	6-23	2.5
Open Type Compressor (note 3)	2-23	0.35	6-23	0.75	6-23	1.5	6-20-23	1.5	6-20-23	2.5

	ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR SOLID CONCRETE FLOORS 4" AND THICKER (NOTE 7)									
	Ground Supported Slab or Basement		20' Floor Span Possible Floor Defl. – 0.67"		30' Floor Span Possible Floor Defl. – 1.0"		40' Floor Span Possible Floor Defl. – 1.33"		50' Floor Span Possible Floor Defl. – 1.67"	
SPECIFICATION SELECTION GUIDE	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.
Refrig. Reciprocating Compressors										
500 rpm to 750 rpm	6-23	0.75	6-23	1.5	6-23	1.5	6-20-23	2.5	6-20-23	3.5
751 rpm and Over	6-23	0.75	6-23	0.25	6-23	1.5	6-20-23	2.5	6-20-23	3.5
Reciprocating Chillers or Heat Pumps										
500 rpm to 750 rpm	6-23	0.75	6-23	1.5	6-23	1.5	6-20-23	2.5	6-20-23	3.5
751 rpm and Over	6-23	0.75	6-23	0.75	6-20-23	1.5	6-20-23	2.5	6-20-23	3.5
PUMPS										
Closed Coupled										
Thru 5 hp	2-21-23	0.35	5-16-21-23	0.75	5-16-21-23	0.75	5-16-21-23	1.5	5-16-21-23	1.5
7 ½ hp and Larger	5-16-21-23	0.75	5-16-21-23	0.75	5-16-21-23	1.5	5-16-21-23	1.5	5-16-21-23	2.5
Base Mounted (note 2)										
Thru 60 hp	5-16-21-23	0.75	5-16-21-23	0.75	5-16-21-23	1.5	5-16-21-23	1.5	5-16-21-23	2.5
75 hp and Larger	5-16-21-23	0.75	5-16-21-23	1.5	5-16-21-23	2.5	5-16-21-23	2.5	5-16-21-23	3.5
FACTORY ASSEMBLED H & V UNITS										
Curb Mounted Roof Top Units			22	1.0	22	2.5	22	2.5	22	2.5
Suspended Units (for Fan Heads see Blowers Guide)										
Thru 5 hp	10-12	1.0	10-12	1.0	10-12	1.0	10-12	1.0	10-12	1.0

	ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR SOLID CONCRETE FLOORS 4" AND THICKER (NOTE 7)									
	Ground Supported Slab or Basement		20' Floor Span Possible Floor Defl. – 0.67"		30' Floor Span Possible Floor Defl. – 1.0"		40' Floor Span Possible Floor Defl. – 1.33"		50' Floor Span Possible Floor Defl. – 1.67"	
SPECIFICATION SELECTION GUIDE	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.	Isol. & Seismic Spec.	Isol. Defl.
7 ½ hp and Larger – 275 rpm to 400 rpm	10-12	1.5	10-12	1.5	10-12	1.5	10-12	1.5	10-12	1.5
7 ½ hp and Larger – 401 rpm and Over	10-12	1.0	10-12	1.0	10-12	1.0	10-12	1.5	10-12	2.5

Notes:

1. Minimum deflection called for in this specification are not 'nominal' but certifiable minimums. The 0.75", 1.5", 2.5", 3.5", and 4.5" minimums should be selected from manufacturers nominal 1", 2", 3", 4" and 5" series respectively. Air spring isolation specifications 8 & 9 may be substituted for steel springs above in highly sensitive noise free locations.

2. Vacuum, Condensate or Boiler Feed Pumps shall be mounted with their tanks on a common spec. 21 base with deflections as specified for base mounted pumps.

3. The base described in specification 20 is used under the drive side. Individual mountings as described in specification 6 are used under the Cooler and Condenser.

4. This type of compressor is highly unbalanced and sometimes requires inertia bases weighing 5 to 7 times equipment weight to reduce running motion.

5. Limit deflection f or utility sets 18" wheel diameter and smaller to 1 1/2".

6. FLOATING CONCRETE INERTIA BASES. Floating concrete inertia bases do not reduce vibration transmitted to the structure through the mountings. These bases will reduce vibratory motion, provide a very rigid machine base and minimize spring reactions to fan thrust. Engineers preferring steel bases rather than the concrete mentioned above in specification 5-21 should change the designation to 5-20. Concrete is preferred for all fans operating at static pressure above 4" and on roof tops.

7. LIGHT FLOOR CONSTRUCTION. When floors or roofs are lighter than 4" solid concrete a localized mass shall be introduce under the vibration mountings in the form of a sub-base. This sub-base should be 12" thick and 12" longer and wider than the mechanical equipment above it. When this mass is provided the 30' minimum static deflection requirements will suffice even in longer bays. The mass is also useful for unusually large bays over 50'. When floors are lighter than the 4" concrete or the location is in a particularly sensitive area and the mass described above cannot be introduced, select deflection requirements for the next larger span.

8. For equipment where increased resiliency and decreased accelerations are required change specification 16 snubbers to specification 17 snubbers.

3.6 VIBRATION ISOLATION AND SEISMIC RESTRAINT INSTALLATION

A. Horizontal pipe isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in specification 11. Specification 11 hangers must also be used in all transverse braced isolated locations. Brace hanger rods with SRC clamps specification 14. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in specification 10. Floor supported piping shall rest on isolators as described in specification 6. Heat exchanger's and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical. Where piping connects to mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.

B. Riser isolation: Risers shall be suspended from specification 10 hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to $\pm$ 25% of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

C. Seismic Restraint of Piping
   1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables if isolated. Specification 12 or 13 restraints may be used on unisolated piping.
      a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is 1" (25mm) I.D. or larger.
      b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" (32mm) I.D. and larger.
      c. All other piping 2 1/2" (64mm) diameter and larger.
   2. Transverse piping restraints shall be at 40' (12m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
   3. Longitudinal restraints shall be at 80' (24m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
   4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
   5. For fuel oil and all gas piping transverse restraints must be at 20' (6m) maximum and longitudinal restraints at 40' (12m) maximum spacing.
   6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" (600m) of the elbow or TEE or combined stresses are within allowable limits at longer distances.
   7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
   8. Branch lines may not be used to restrain main lines.

D. Vibration Isolation of Ductwork
   1. All discharge runs for a distance of 50' (15m) 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" (19mm).
   2. All duct runs having air velocity of 1000 fpm (5 m/s) or more shall be isolated from the building structure by specification 11 hangers or specification 5 floor supports. Spring deflection shall be a minimum of 0.75" (19mm).
   3. Flexible duct connections shall be provided at inlet and discharge ducts. Refer to Section 23 33 00.

E. Seismic Restraint of Ductwork
   1. Seismically restrain all duct work with specification 12 or 13 restraints as listed below:
      a. Restrain rectangular ducts with cross sectional area of 6 sq.ft. (.5 m^2) or larger.
      b. Restrain round ducts with diameters of 28" (700mm) or larger.
      c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
   2. Transverse restraints shall occur at 30' (9mm) 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.
   3. Longitudinal restraints shall occur at 60' (18m) intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4' (1.2m) 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.
   4. 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.
   5. 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.
   6. Walls, including gypsum board non bearing 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.

F. Vibration Isolation and Seismic Restraint of Mechanical Equipment
   1. All mechanical equipment shall be vibration isolated and seismically restrained as per the schedules in part 3.5 of this specification.
   2. Equipment mounted on housekeeping pads: Pads shall be properly doweled or expansion shielded to deck to meet acceleration criteria.
   3. Requirements for installation on concrete inertia bases shall be as follows:
      a. Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".
      b. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
      c. The isolators shall be installed without raising the machine and frame assembly.
      d. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
      e. Install equipment with flexibility in wiring connection.

f. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".

g. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators, or seismic restraints.

3.7 SEISMIC RESTRAINT EXCLUSIONS

A. General: All mechanical and electrical components and systems that are considered exempt from the requirement for seismic restraint, in accordance with The International Building Code – 2012 and all related State of Connecticut Supplements, shall not require seismic restraint.

B. Piping

1. Piping in boiler and mechanical rooms less than 1 1/4" (32mm) inside diameter.
2. All other piping less than 2 1/2" (64mm) inside diameter.
3. All piping suspended by individual hangers 12" (300mm) or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" (300mm) limit is exceeded by any hanger in the run, seismic bracing is required for the run.
4. The 12" (300mm) exemption applies for trapeze supported systems if the top of each item supported by the trapeze qualifies.

C. Ductwork

1. Rectangular and square and ducts that are less than 6 square feet in cross sectional area.
2. Oval ducts that are less than 6 square feet (.5m^2) in cross sectional area based on nominal size.
3. Round duct less than 28" (.5m^2) in diameter.
4. All duct suspended by hangers 12" (300mm) or less in length as measured from the top of the duct to the point of attachment to the structure. Hangers must be attached within 2" (50mm) of the top of the duct with a minimum of two #10 sheet metal screws. If the 12" (300mm) limit is exceeded by any hanger in the run, seismic bracing is required for the run.

3.8 INSPECTION

A. Examine systems under provisions of Division 1.

B. On completion of installation of all vibration isolation devices herein specified, the local representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Nameplates.
2. Tags.
3. Pipe markers.
4. Ceiling tacks.
5. Labels.
6. Lockout devices.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
1. Craftmark Identification Systems
2. Safety Sign Co.
3. Seton Identification Products
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

A. Plastic Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Refer to Section 01 60 00 - Product Requirements.
2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.

B. Metal Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Refer to Section 01 60 00 - Product Requirements.
2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter] with finished edges.

C. Information Tags:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products

d. Substitutions: Refer to Section 01 60 00 - Product Requirements

2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

D. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Refer to Section 01 60 00 - Product Requirements.
2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Refer to Section 01 60 00 - Product Requirements.
2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:
1. Manufacturers:
a. Seaton
b. Electro Tape
c. Pratt Tyco
d. Substitutions: Refer to Section 01 60 00 - Product Requirements.
2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.4 CEILING TACKS

A. Manufacturers:
1. Craftmark Identification Systems
2. Safety Sign Co.
3. Seton Identification Products
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Steel with 3/4 inch diameter color-coded head.

C. Color code as follows:
1. HVAC equipment: Yellow.
2. Fire dampers/smoke dampers: Red.
3. Plumbing valves: Green.
4. Heating/cooling valves: Blue.

2.5 LABELS

A. Manufacturers:
1. Craftmark Identification Systems
2. Safety Sign Co.
3. Seton Identification Products
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification [and bar code].

2.6 LOCKOUT DEVICES

A. Lockout Hasps:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Refer to Section 01 60 00 - Product Requirements.
2. Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

B. Valve Lockout Devices:
1. Manufacturers:
a. Craftmark Identification Systems
b. Safety Sign Co.
c. Seton Identification Products
d. Substitutions: Refer to Section 01 60 00 - Product Requirements.
2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

B. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

C. Install tags using corrosion resistant chain. Number tags consecutively by location.

D. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

E. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Identify air terminal units and radiator valves with numbered tags.

I. Tag automatic controls, instruments, and relays. Key to control schematic.

J. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

K. Identify ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

L. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Testing adjusting, and balancing of air systems.
2. Testing adjusting, and balancing of hydronic systems.
3. Measurement of final operating condition of HVAC systems.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 09 00 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.2 REFERENCES

A. Testing Adjusting and Balancing Bureau
1. TABB- ANSI Accredited HVAC testing, adjusting and balancing certification program which conforms to ISO/IEC 17024 and endorsed by SMACNA.

B. Associated Air Balance Council:
1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

C. Natural Environmental Balancing Bureau:
1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on forms containing information indicated in Schedules.

D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of certification.

F. Submit draft copies of report for review prior to final acceptance of Project.

G. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced

drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with the applicable standard.

B. Prior to commencing Work, calibrate each instrument to be used.

1.6 QUALIFICATIONS

A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC, certified by NEBB or certified by TABB (Testing, Adjusting, and Balancing Bureau).

B. Perform Work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor or personnel certified by TABB (Testing, Adjusting, and Balancing Bureau).

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

A. Section 01 10 00 - Summary: Work sequence.

B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify systems are complete and operable before commencing work. Verify the following:
1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.

3.2 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Verify recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

E. Report defects and deficiencies noted during performance of services, preventing system balance.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Provide quantity of 2 sheave drive changes to vary fan speed for each fan. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.

M. Where available fan capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.6 WATER SYSTEM PROCEDURE

A. Adjust water systems, after air balancing, to obtain design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.

C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.7 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
1. Fire Pumps.
2. Plumbing Pumps.
3. HVAC Pumps.
4. Condensing Boilers.
5. Air Cooled Water Chillers.
6. Air Coils.
7. Terminal Heat Transfer Units.
8. Air Handling Units.
9. Fans.
10. Air Terminal Units.
11. Air Inlets and Outlets.

B. Report Forms
1. Title Page:
   a. Name of Testing, Adjusting, and Balancing Agency
   b. Address of Testing, Adjusting, and Balancing Agency
   c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
   d. Project name
   e. Project location
   f. Project Architect
   g. Project Engineer
   h. Project Contractor
   i. Project altitude
   j. Report date
2. Summary Comments:
   a. Design versus final performance
   b. Notable characteristics of system
   c. Description of systems operation sequence

d. Summary of outdoor and exhaust flows to indicate building pressurization
e. Nomenclature used throughout report
f. Test conditions

3. Instrument List:
   a. Instrument
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Range
   f. Calibration date
4. Electric Motors:
   a. Manufacturer
   b. Model/Frame
   c. HP/BHP and kW
   d. Phase, voltage, amperage; nameplate, actual, no load
   e. RPM
   f. Service factor
   g. Starter size, rating, heater elements
   h. Sheave Make/Size/Bore
5. V-Belt Drive:
   a. Identification/location
   b. Required driven RPM
   c. Driven sheave, diameter and RPM
   d. Belt, size and quantity
   e. Motor sheave diameter and RPM
   f. Center to center distance, maximum, minimum, and actual
6. Pump Data:
   a. Identification/number
   b. Manufacturer
   c. Size/model
   d. Impeller
   e. Service
   f. Design flow rate, pressure drop, BHP and kW
   g. Actual flow rate, pressure drop, BHP and kW
   h. Discharge pressure
   i. Suction pressure
   j. Total operating head pressure
   k. Shut off, discharge and suction pressures
   l. Shut off, total head pressure
7. Chillers:
   a. Identification/number
   b. Manufacturer
   c. Capacity
   d. Model number
   e. Serial number
   f. Evaporator entering water temperature, design and actual
   g. Evaporator leaving water temperature, design and actual
   h. Evaporator pressure drop, design and actual
   i. Evaporator water flow rate, design and actual
   j. Condenser entering water temperature, design and actual
   k. Condenser pressure drop, design and actual
   l. Condenser water flow rate, design and actual

8. Cooling Coil Data:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Air flow, design and actual
   f. Entering air DB temperature, design and actual
   g. Entering air WB temperature, design and actual
   h. Leaving air DB temperature, design and actual
   i. Leaving air WB temperature, design and actual
   j. Water flow, design and actual
   k. Water pressure drop, design and actual
   l. Entering water temperature, design and actual
   m. Leaving water temperature, design and actual
   n. Air pressure drop, design and actual
9. Heating Coil Data:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Air flow, design and actual
   f. Water flow, design and actual
   g. Water pressure drop, design and actual
   h. Entering water temperature, design and actual
   i. Leaving water temperature, design and actual
   j. Entering air temperature, design and actual
   k. Leaving air temperature, design and actual
   l. Air pressure drop, design and actual
10. Air Moving Equipment:
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Arrangement/Class/Discharge
   f. Air flow, specified and actual
   g. Return air flow, specified and actual
   h. Outside air flow, specified and actual
   i. Total static pressure (total external), specified and actual
   j. Inlet pressure
   k. Discharge pressure
   l. Sheave Make/Size/Bore
   m. Number of Belts/Make/Size
   n. Fan RPM
11. Return Air/Outside Air Data:
   a. Identification/location
   b. Design air flow
   c. Actual air flow
   d. Design return air flow
   e. Actual return air flow
   f. Design outside air flow
   g. Actual outside air flow
   h. Return air temperature

i. Outside air temperature
j. Required mixed air temperature
k. Actual mixed air temperature
l. Design outside/return air ratio
m. Actual outside/return air ratio

12. Exhaust Fan Data:
    a. Location
    b. Manufacturer
    c. Model number
    d. Serial number
    e. Air flow, specified and actual
    f. Total static pressure (total external), specified and actual
    g. Inlet pressure
    h. Discharge pressure
    i. Sheave Make/Size/Bore
    j. Number of Belts/Make/Size
    k. Fan RPM
13. Duct Traverse:
    a. System zone/branch
    b. Duct size
    c. Area
    d. Design velocity
    e. Design air flow
    f. Test velocity
    g. Test air flow
    h. Duct static pressure
    i. Air temperature
    j. Air correction factor
14. Duct Leak Test:
    a. Description of ductwork under test
    b. Duct design operating pressure
    c. Duct design test static pressure
    d. Duct capacity, air flow
    e. Maximum allowable leakage duct capacity times leak factor
    f. Test apparatus
        1) Blower
        2) Orifice, tube size
        3) Orifice size
        4) Calibrated
    g. Test static pressure
    h. Test orifice differential pressure
    i. Leakage
15. Air Monitoring Station Data:
    a. Identification/location
    b. System
    c. Size
    d. Area
    e. Design velocity
    f. Design air flow
    g. Test velocity
    h. Test air flow

16. Terminal Unit Data:
    a. Manufacturer
    b. Type, constant, variable, single, dual duct
    c. Identification/number
    d. Location
    e. Model number
    f. Size
    g. Minimum static pressure
    h. Minimum design air flow
    i. Maximum design air flow
    j. Maximum actual air flow
    k. Inlet static pressure
17. Air Distribution Test Sheet:
    a. Air terminal number
    b. Room number/location
    c. Terminal type
    d. Terminal size
    e. Area factor
    f. Design velocity
    g. Design air flow
    h. Test (final) velocity
    i. Test (final) air flow
    j. Percent of design air flow

END OF SECTION

SECTION 230700 - HVAC INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. HVAC piping insulation, jackets and accessories.
2. HVAC equipment insulation, jackets and accessories.
3. HVAC ductwork insulation, jackets, and accessories.

B. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 REFERENCES

A. ASTM International:
1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
3. ASTM C450 - Standard Practice for Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments.
4. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
5. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
6. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
7. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
8. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
9. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
10. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
11. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
12. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
13. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
14. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

B. Sheet Metal and Air Conditioning Contractors' National Association':
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

C. Underwriters Laboratories Inc.:
1. UL 1978 - Standard for Safety for Grease Ducts.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

D. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years experience.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer's standard, no less than one year from date of Owner's acceptance.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
1. CertainTeed.
2. Knauf.
3. Johns Manville.
4. Owens-Corning.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
1. Aeroflex. Aerocell.
2. Armacell, LLC. Armaflex.
3. Nomaco. K-flex.
4. Substitutions: Section 01 60 00 - Product Requirements.

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.

C. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F.

2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:
1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Pipe Jacket:
1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 15 mil.
3. Connections: Brush on welding adhesive.

C. Aluminum Pipe Jacket:
1. ASTM B209.
2. Thickness: 0.020 inch thick sheet.
3. Finish: Smooth.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

G. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-8: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

2.6 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.27 at 75 degrees F.

2. Maximum Operating Temperature: 250 degrees F.
3. Density: 1.0 pound per cubic foot.

B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied all service facing meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Density: 3.0 pound per cubic foot.

C. TYPE D-4: ASTM C1071, ASTM, 1104 Type I, flexible, glass fiber duct liner with coated air side.
1. Thermal Conductivity: 0.25 at 75 degrees F.
2. Density: 2.75 pound per cubic foot.
3. Maximum Operating Temperature: 250 degrees F.
4. Maximum Air Velocity: 6,000 feet per minute.

D. TYPE D-5: ASTM C1071, ASTM 1104, Type II, rigid, glass fiber duct liner with coated air side.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Density: 3.0 pound per cubic foot.
3. Maximum Operating Temperature: 250 degrees F.
4. Maximum Air Velocity: 4,000 feet per minute.

E. TYPE D-6: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Service Temperature Range: Range: Minus 58 to 180 degrees F.

F. TYPE D-8: Inorganic blanket encapsulated with scrim reinforced foil meeting UL 1978.
1. Thermal Conductivity: 0.42 at 500 degrees F.
2. Weight: 1.4 pound per square foot.
3. Surface Burning Characteristics: Maximum 0/0 flame spread/smoke developed index when tested in accordance with ASTM E84.

2.7 DUCTWORK INSULATION JACKETS

A. Vapor Retarder Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
3. Secure with pressure sensitive tape.

2.8 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof, ASTM E162 fire-retardant type.

D. Liner Fasteners: Galvanized steel, welded with integral head.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Adhesives: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify piping, equipment and ductwork has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature (Including fluid coupled with ground heat exchanger routed within the building's interior):
1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Hot Piping Systems:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

F. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install [galvanized] steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
   a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
   b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

G. Insulation Terminating Points:
1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

H. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

J. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

K. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F Or Less:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

G. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

3.4 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are finished inside dimensions.

B. Insulated ductwork conveying air below ambient temperature:
1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. External Glass Fiber Duct Insulation:
1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
6. Provide additional insulation to pitch top surface at least an 1/8” per foot from the center to each side to minimize standing water.

D. External Elastomeric Duct Insulation:
1. Adhere to clean oil-free surfaces with full coverage of adhesive.
2. Seal seams and butt joints with manufacturer’s recommended adhesive.
3. When application requires multiple layers, apply with joints staggered.

4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
5. Lift ductwork off trapeze hangers and insert spacers.

E. Duct and Plenum Liner:
1. Adhere insulation with adhesive for 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

F. Kitchen Exhaust Ductwork:
1. Cover duct by wrapping with insulation using checkerboard overlap method.
2. Overlap seams of each method by 3 inches.
3. Attach insulation using steel banding or by welded pins and clips.
4. Install insulation without sag on underside of ductwork. Use additional fasteners to prevent sagging.

3.5 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Chilled Water Supply and Return	P-1 (outer layer) P-2 (inside layers)	1-1/4 inches and smaller 1-1/2 inches inch and larger	1½ inch 1½ inch
Condensate Piping from Cooling Coils	P-5	All sizes	½ inch
Refrigerant	P-5	Less than 1 1/2 ” 1 1/2 ” inch and larger	½ inch 1 inch

B. Heating Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Heating Water Supply and Return [141 to 200 degrees F]	P-1 (outer layer) P-2 (inner layer)	1-1/4 inches and smaller 1-1/2 inches inch and larger	1-1/2inches 2 inches

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches
Chilled Water Pump Bodies	E-8	1.0
Chilled Water Air Separators	E-8	1.0
Chilled Water Expansion Tanks	E-8	1.0

D. Ductwork Insulation Schedule:

DUCTWORK SYSTEM	INSULATION TYPE	INSULATION THICKNESS inches
Supply Ducts (externally insulated REGARDLESS OF ANY INTERNAL LINING REQUIREMENTS) [Thickness indicated is installed thickness.]	D-1, D-2, D-6	1.0
Return Ducts (externally insulated REGARDLESS OF ANY INTERNAL LINING REQUIREMENTS) [Thickness indicated is installed thickness.]	D-1, D-2, D-6	1.0
Kitchen Exhaust Duct (2 layers of 1-1/2 inch each)	D-8	3.0
Exhaust Ducts Within 10 feet of Exterior Openings [Thickness indicated is installed thickness.]	D-1, D-2	1.0
Exhaust Ducts Exposed to Outdoor Air	D-1 or D-2	2.0
Rectangular Supply Ducts Downstream of Variable Air Volume Boxes (internally insulated for 10')	D-4, D-5	1.0
Transfer Air Ducts (internally insulated)	D-4, D-5	1.0

END OF SECTION

SECTION 23 08 00 - COMMISSIONING OF HVAC SYSTEMS

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.

B. The OPR and BOD documentation are included by reference for information only.

1.2 SUMMARY

A. This section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

A. Refer to Division 01 Section “General Commissioning Requirements” for the description of commissioning.

1.4 DEFINITIONS

A. Refer to Division 01 Section “General Commissioning Requirements” for definitions.

1.5 SUBMITTALS

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s role.

B. Refer to Division 01 Section “Submittals” for specific requirements. In addition, provide the following:

C. Certificates of readiness

D. Certificates of completion of installation, prestart, and startup activities.

E. O&M manuals

F. Test reports

1.6 QUALITY ASSURANCE

A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC&R system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems

B. Red-lined Drawings: The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.

C. Operation and Maintenance Data: Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been mad by the Contractor.

D. Demonstration and Training: Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior the training session

3.2 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning functional test procedures at the direction of the CxA. This includes but is not limited to the controls contractor verifying with the CxA that all sequences of operations are functioning properly.

B. Attend construction phase controls coordination meetings.

C. Attend testing, adjusting, and balancing review and coordination meetings.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation. This may include but is not limited to pipe pressure tests, duct leakage tests and flushing / cleaning reports.

F. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.

G. Prepare preliminary schedule for Mechanical system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, testing and balancing and task completion for owner. Distribute preliminary schedule to commissioning team members.

H. Update schedule as required throughout the construction period.

I. Assist the CxA in all verification and functional performance tests. While the CxA is onsite the contractor does not need to be with the CxA throughout the entire day but only needs to be available if assistance is needed (such as turning a piece of equipment on). The exception is that the controls contractor is expected to verify all sequences of operation with the CxA.

J. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

K. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.

L. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.

M. Notify the CxA a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.

N. Participate in, and schedule vendors and contractors to participate in the training sessions.

O. Provide written notification to the CM/GC and CxA Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.

P. The equipment supplier shall document the performance of his equipment.

Q. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.

R. Test, Adjust and Balance Contractor
1. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
2. Submit the site specific testing and balancing plan to the CxA and AE for review and acceptance.
3. Attend the testing and balancing review meeting scheduled by the CxA. Be prepared to discuss the procedures that shall be followed in testing, adjusting, and balancing the HVAC&R system.
4. At the completion of the testing and balancing work, and the submittal of the final testing and balancing report, notify the HVAC&R contractor and the CM/GC.
5. At the completion of testing and balancing work, and the submittal of the final testing and balancing report, notify the HVAC&R Contractor and the CM/GC.
6. Participate in verification of the testing and balancing report, which will consist of repeating measurements contained in the testing and balancing reports. Assist in diagnostic purposes when directed.

S. Equipment Suppliers
1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
2. Assist in equipment testing per agreements with contractors.
3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.

T. Refer to Division 01 Section “General Commissioning Requirements” for additional contractor responsibilities.

3.3 CxA'S RESPONSIBILITIES

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s Responsibilities.

3.4 TESTING PREPARATION

A. Certify in writing to the CxA that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify in writing to the CxA that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify in writing that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.5 TESTING, ADJUSTING AND BALANCING VERIFICATION

A. Prior to performance of Testing, Adjusting and Balancing work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least ten (10) days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing subcontractor ten (10) days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.6 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R contractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.7 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 23 sections. Provide submittals, test data, inspector record, and certifications to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections. Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment: Test requirements are specified in Division 23 piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

F. Vibration and Sound Tests**:** Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

G. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

HVAC Systems
Heating, ventilating, air conditioning, and refrigeration systems
Energy management control system
Testing, Adjusting and Balancing (TAB) spot check
Renewable energy systems, if applicable

3.8 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.9 APPROVAL

A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.10 DEFERRED TESTING

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.11 OPERATION AND MAINTENANCE MANUALS

A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.

B. Refer to Division 01 Section “General Commissioning Requirements” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.12 TRAINING OF OWNER PERSONNEL

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to training.

END OF SECTION 23 08 00

SECTION 230900 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Control panel enclosures.
2. Humidistats.
3. Thermostats.
4. Time clocks.
5. Control air dampers.
6. Electric damper actuators.
7. Control valves.
8. Electric valve actuators.
9. Air measuring and modulation device.
10. Direct digital control system components.
11. Differential pressure monitor.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors.
3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
4. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for thermometer sockets and gage taps for placement by this section. Installation requirements for piping products furnished in this section.
5. Section 23 33 00 - Air Duct Accessories: Product requirements for duct mounted thermometers. Installation requirements for dampers and other duct mounted products furnished in this section.
6. Division 26: Execution requirements for electric connections specified by this section.

1.2 WORK INCLUDED

A. Furnish a, Building Automation System comprised of a network utilizing high-speed BACnet for communications between Building Controllers and PC Workstations. LonTalk or BACnet sub-networks shall be used for communications between Building Controllers, Custom Application Controllers and Application Specific Controllers. Include an operator's workstation using Microsoft Windows 2000 Professional, XP Professional, or Vista as the operating system based on a distributed control system in accordance with this specification. The operator's workstation and all building controllers shall communicate using protocols and network standards as defined by ANSI/ASHRAE Standard 135–2001, BACnet. Programmable controllers, and all input/output devices shall communicate using the LonTalk FTT-10 and LonMark profiles and/or use BACnet MSTP protocols and network standards as defined by ANSI/ASHRAE Standard 135–2001, BACnet. No gateways shall be used for communication to controllers installed under this section. Gateways may be used for communication to existing systems or to systems installed under other sections.

B. Provide all necessary LonTalk and/or BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and the System Controller

C. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

D. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

E. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

F. Provide and install all interconnecting cables between supplied cabinets, Programmable controllers, and input/output devices.

G. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

H. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

I. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

J. Provide a comprehensive operator and technician training program as described herein.

K. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

L. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

1.3 SYSTEM DESCRIPTION

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. The Enterprise wide network will be provided by the owner and supports the Internet Protocol (IP). Local connections of the Building Controller shall be on ISO 8802-3 (Ethernet). Each Building Controller shall perform communications to a network of Custom Application and Application Specific Controllers using LonTalk FTT-10 and LonMark profiles and/or use BACnet MSTP as prescribed by the BACnet standard to perform communications to a network of Custom Application and Application Specific Controllers. This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, heat pumps, fan-coils, AC units, etc. and all air handlers, boilers, chillers, and any other listed equipment using LonTalk FTT-10 and LonMark profiles and/or use BACnet MSTP as prescribed by the BACnet standard. Proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

B. Operator's workstation software shall be Microsoft Windows 2000 Professional, XP Professional, or Vista as the computer operating system. The Energy Management and Control System (EMCS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, full suite of field engineering tools including graphical programming and applications. Systems using operating systems other than that described above are strictly prohibited. All software required to program Programmable specific controllers and all field level devices and controllers will be left with the owner. All software passwords required to program and make future changes to the system will also become the property of the owner. All software required to make any program changes anywhere in the system along with scheduling, and trending applications will be left with the owner. All software passwords required to program and make future changes to schedules, trends and related program changes will also become the property of the owner.

C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage. E.

D. Room sensors shall be provided with digital readout that allow the user to view room temperature, [view outside air temperature] adjust the room setpoint within preset limits and allow occupied override set by OWS. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow technician to balance VAV zones and access any parameter in zone controller.

E. Plate sensors shall be provided as shown on drawings. Include all necessary wiring and firmware such that plate sensor can include a field service mode (by removing plate). Field service capability shall allow technician to balance VAV zones and access any parameter in zone controller.

1.4 APPROVED MANUFACTURERS

A. Provide bid based on one of the following manufacturers:
1. Alerton
2. Automated Logic Corp.
3. Trane

B. No Others will be accepted

C. Above listed manufacturers must meet all portions of the specifications. Listed vendors cannot assume they are acceptable without meeting all requirements.

1.5 QUALITY ASSURANCE

A. The BAS system shall be designed and installed, commissioned and serviced by factory trained personnel. Manufacturer shall have an in-place support facility within 1 hours response time of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment.

B. The Bidder shall be regularly engaged in the installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

C. The BAS system manufacturer must have a Dealer or Customer Support call-in Center located at the corporate headquarters or corporate manufacturing facilities. The Customer Support call-in Center will be staffed by fully trained and certified technicians.

D. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

E. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

F. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

G. Control system shall be engineered, programmed and supported completely by representative’s local office that must be within 50 miles of project site.

1.6 REFERENCE STANDARDS

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof , shall govern design and selection of equipment and material supplied:
1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
2. ANSI/ASHRAE Standard 135-2001, BACnet.
3. ANSI/EIA/CEA-709.1 (LonTalk)
4. ANSI MC85.1 - Terminology for Automatic Control
5. Uniform Building Code (UBC), including local amendments.
6. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
7. National Electrical Code (NEC).
8. FCC Part 15, Subpart J, Class A
9. EMC Directive 89/336/EEC (European CE Mark)
10. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated the system supplier shall secure and pay for all permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.

1.7 SUBMITTALS

A. Drawings
1. The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.
2. Drawings shall be submitted in the following standard sizes: 11” x 17” (ANSI B).
3. Eight complete sets (copies) of submittal drawings shall be provided.
4. Drawings shall be available on CD-ROM.

B. System Documentation

C. Include the following in submittal package:
1. System configuration diagrams in simplified block format.
2. All input/output object listings and an alarm point summary listing.
3. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
4. Complete bill of materials, valve schedule and damper schedule.
5. System graphics showing monitored systems, data (connected and calculated) point addresses, and operator notations.
6. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
7. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.
8. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.
9. For operator’s workstation(s) and building controller(s) provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2001.
10. Provide complete description and documentation of any proprietary services and/or objects used in the system.
11. A list of all functions available and a sample of function block programming that shall be part of delivered system.
12. System communication riser detailing network architecture and front end hardware delivery

D. Project Management
1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents and shall indicate timing and dates for system installation, debugging, and commissioning.

1.8 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.
   2. Submit data specified in "Submittals" in final "Record Documents" form.

C. Operation and Maintenance Data:
   1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered system components and devices.
   2. Submit keyboard illustrations and step-by-step procedures indexed for each operator function.
   3. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.9 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 MAINTENANCE SERVICE

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of control systems for two years from Date of Substantial Completion.

C. Furnish complete service of controls systems, including callbacks. Make minimum of four complete normal inspections of approximately eight hours duration in addition to normal service calls to inspect, calibrate, and adjust controls. Submit written report after each inspection.

D. Furnish four complete inspections per year, one in each season, to inspect, calibrate, and adjust controls. Submit written report after each inspection.

E. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

F. Perform work without removing units from service during building normal occupied hours.

G. Provide emergency call back service at all hours for this maintenance period.

H. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

I. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

J. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.12 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours Monday through Friday, 48 hours on Saturday and Sunday.

C. This warranty shall apply equally to both hardware and software.

PART 2 PRODUCTS

2.1 OPERATOR'S WORKSTATION

A. General structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 clients simultaneously.

B. BACnet Conformance

1. Operator's workstation shall as a minimum support Point-to-Point (PTP) and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a BACnet device. Operator's terminal shall comply with the requirements of a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:
   a. Clock Functional Group
   b. Event Response Functional Group
   c. Time Master Functional Group
   d. Device Communications
2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types accessed by the workstation shall include as a minimum: Analog Value, Analog Input, Analog Output, Binary Value, Binary Input, Binary Output, Calendar, Device, Event Enrollment, File, Notification Class, Program and Schedule

object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

4. The Operator Workstation shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs). Workstation shall support Foreign Device Registration to allow temporary workstation connection to IP network.

C. Displays

1. Operator's workstation shall display all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator's workstation shall display all data using three-dimensional graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user. Workstation shall allow user to change all field-resident EMCS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.
2. All displays and programming shall be generated and customized by the local EMCS supplier and installer. Systems requiring factory development of graphics or programming of DDC logic are specifically prohibited.
3. Binary objects shall be displayed as ACTIVE/INACTIVE/NULL or with customized text. Text shall be justified left, right or center as selected by the user. Also, allow binary objects to be displayed as individual change-of-state graphic objects on the display screen such that they overlay the system graphic. Each binary object displayed in this manner shall be assigned up to three graphic files for display when the point is ON, OFF or in alarm. For binary outputs, toggle the object's commanded status when the graphic item is selected with the system mouse. Similarly, allow the workstation operator to toggle the binary object's status by selecting with the mouse a graphic of a switch or light, for example, which then displays a different graphic (such as an "ON" switch or lighted lamp). Additionally, allow binary objects to be displayed as an animated graphic. Animated graphic objects shall be displayed as a sequence of multiple graphics to simulate motion. For example: when a pump is in the OFF condition, display a stationary graphic of the pump. When the operator selects the pump graphic with the mouse, the represented object's status is toggled and the graphic of the pump's impeller rotates in a time-based animation. The operator shall be able to click on an animated graphical object or switch it from the OFF position to ON, or ON to OFF. Allow operator to change graphic file assignment and also create new and original graphics online. System shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.
4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to

the system graphic. Each analog input object may be assigned a minimum of five graphic files, each with high/low limits for automatic selection and display of these graphics. As an example, a graphic representation of a thermometer would rise and fall in response to either the room temperature or its deviation from the controlling setpoint. Analog output objects, when selected with the mouse, shall be displayed as a prompted dialog (text only) box. Selection for display type shall be individual for each object. Analog object values may be changed by selecting either the "increase" or "decrease" arrow in the analog object spinner box without using the keypad. Pressing the button on the right side of the analog object spinner box allows direct entry of an analog value and accesses various menus where the analog value may be used, such as trendlogs.

5. Analog objects may also be assigned to an area of a system graphic, where the color of the defined area changes based on the analog object's value. For example, an area of a floor-plan graphic served by a single control zone would change color with respect to the temperature of the zone or its deviation from setpoint. All editing and area assignment shall be created or modified online using simple icon tools.
6. A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label push buttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A security level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
7. A mouse shall be used to move the pointer arrow to the desired item for selection of new display or to allow the operator to make changes to object data.

D. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.

   Each operator's terminal shall provide security for 200 users minimum. Each user shall have an individual User ID, User Name and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be 0–8 characters, User Name shall be 0–29 characters, and Password shall be 4–8 characters long. Each system user shall be allowed individual assignment of only those control functions and menu items to which that user requires access. All passwords, user names, and access assignments shall be adjustable online at the operator's terminal. Each user shall also have a set security level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct security levels for assignment to users.

   System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

E. Operator Activity Log

1. Operator Activity Log shall be included with system that tracks all operator changes and activities. System shall track what is changed in the system, who performed this change, date and time of system activity and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation.
2. Log shall be gathered and archived to hard drive on operator workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.
3. Any displayed data, that is changeable by the operator, may be selected using the right mouse button and the operator activity log shall then be selectable on the screen. Selection of the operator activity log using this method shall show all operator changes of just that displayed data.

F. Scheduling

1. Operator's workstation shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily with events being the highest.
2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
4. System shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through all steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right clicking on value displayed on graphic and then selecting Schedule.
5. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

G. Alarm Indication and Handling.

1. Operator's workstation shall provide audible, visual, and printed means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s), currently running. Printout of alarms shall be sent to the assigned terminal and port.
2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment and identification of operator acknowledging alarm .
3. Alarm messages shall be in user-definable text (English or other specified language) and shall be entered either at the operator's terminal or via remote communication.
4. System shall include an Alarm Wizard for set up of alarms. Wizard shall walk user through all steps necessary for alarm generation. Wizard shall have its own pull-down

selection for startup or may be started by right clicking on value displayed on graphic and then selecting alarm setup.

H. Trendlog Information

1. System server shall periodically gather historically recorded data stored in the building controllers and archive the information Archived files shall be appended with new sample data, allowing samples to be accumulated. Systems that write over archived data shall not be allowed, unless limited file size is specified. Samples may be viewed at the operator's workstation. Operator shall be able to scroll through all trended data. All trendlog information shall be displayed in standard engineering units.
2. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to ten object types at the same time in different colors. Graphs shall show object values relative to time.
3. Operator shall be able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.
4. System shall include a trend Wizard for setup of logs. Wizard shall walk user through all necessary steps. Wizard shall have its own pull-down selection for startup, or may be started by right clicking on value displayed on graphic, and then selecting Trendlogs from the displayed menu.

I. Energy Log Information

1. System server shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.
2. All data shall be stored in data base file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
3. Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.
4. System shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format the user shall be able to select a specific period of data to view.

J. Demand Limiting

1. System shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.
2. Binary shedding shall include minimum of 5 priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one the

loads shall be shed/restored in a “first off-first on” mode and in the other the loads are just shed/restored in a linear fashion.

3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.
4. Status of each and every load shed program shall be capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.
5. Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.

K. Field Engineering Tools – Engineering Tools Must Be Submitted on.

1. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.
2. User shall be able to pick graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
3. Programming tools shall include a real time operation mode. Function blocks shall display real time data and be animated to show status of data inputs and outputs when in real time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.
5. Field engineering tool shall include Device Manager for automatic detection of devices connected anywhere on the BACnet network by scanning of the entire network. This function shall display device instance, network identification, model number and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computers hard drive. If needed, this file shall be downloaded to the appropriate controller by selection using the mouse.
6. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media.

L. Workstation Hardware

1. Provide operator’s workstation(s) at location(s) noted on the plans.
2. Workstation/Server Computer Minimum Requirements
   a. Pentium 2 Duo core, 2.8 Ghz or better
   b. 1 GB RAM or better
   c. 80GB hard disk or better
   d. High-performance graphics adapter
   e. Ethernet 10/100 network interface card
   f. Keyboard, monitor, mouse, and CD-ROM

g. Windows 2000 Professional or later
h. Color Printer (Inkjet, Color Dye or Laser)

M. Software
1. At the conclusion of project, contractor shall leave with owner a CD ROM that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

2.2 Web Interface

A. General
1. BAS supplier shall provide web-based access to the system as part of standard installation. User shall be able to access all displays of real-time data that are part of the BAS via a standard Web browser. Web browser shall tie into the network via owner-supplied Ethernet network connection. Web-page host shall be a separate device that resides on the BAS BACnet network, but is not the BAS server for the control system. BAS server must be a separate computer from the Web-page host device to ensure data and system integrity. The web-page software shall not require a per user licensing fee or annual fees. The web-page host must be able to support on average 50 simultaneous users with the ability to expand the system to accommodate an unlimited number of users.

B. Browser Technology
1. Browser shall be standard version of Microsoft IE, Mozilla Firefox or Google Chrome. No special vendor-supplied software shall be needed on computers running browser. All displays shall be viewable and the Web-page host shall directly access real-time data from the BAS BACnet network. Data shall be displayed in real time and update automatically without user interaction. User shall be able to change data on displays if logged in with the appropriate user name and password.

C. Communications
1. Web-page host shall include two Ethernet network connections. One network connection shall be dedicated to BAS BACnet network and shall be used to gather real-time data from all the BACnet devices that form the BAS. This network shall communicate via BACnet, allowing the Web-page host to gather data directly from units on the local LAN or from other projects connected over a WAN. This network shall also provide the connection to the BAS server for Web page generation.
2. The second Ethernet connection shall provide the physical connection to the Internet or an IP-based WAN. It shall be the port that is used for the browser to receive Web pages and data from the Web-page host. The Web-page host shall act as a physical barrier between the BAS network and the WAN or Internet connection that allows the browser to receive web pages and data. The two separate network connections provide for a physical barrier to prevent raw BACnet traffic being exposed on the IP network.
3. The Web-page host shall provide for complete isolation of the IP and BACnet networks by not routing networking packets between the two networks.
4. BAS BACnet Ethernet network shall be provided and installed by the BAS supplier. Owner shall provide and incur any monthly charges of WAN/Internet connection.

D. Display of Data
1. Web page graphics shown on browser shall be replicas of the BAS displays. User shall need no additional training to understand information presented on Web pages when compared to what is shown on BAS displays. Web page displays shall include animation just as BAS displays. Fans shall turn, pilot lights shall blink, coils shall change colors, and so on.
2. Real-time data shall be shown on all browser Web pages. This data must be directly gathered via the BACnet network and automatically updated on browser Web page displays without any user action. Data on the browser shall automatically refresh as changes are detected without re-drawing the complete display.
3. It shall be possible for user from browser Web page to change data if the user is logged on with the appropriate password. Clicking on a button or typing in a new value shall change digital data. Using pull-down menus or typing in a new value shall change analog data.
4. Data displays shall be navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.

E. Time Schedule Adjustment
1. Web access shall allow user to view and edit all schedules in the system. This includes standard, holiday and event schedules as described in BAS specification. Display of schedules shall show interaction of all schedules on a single display so user sees an overview of how all work together. User shall be able to edit schedules from this display.
2. Display of all 3 schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
3. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

F. Logging of Information
1. User shall use standard browser technology to view all trend logs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust y axis of data viewed in graphical format. User shall also be able to down-load data through the web interface to local computer. Data shall be in CSV format.

G. Alarm Handling
1. Web interface shall display alarms as they occur. User shall be able to acknowledge alarms using browser technology. In addition, user shall be able to view history of alarm occurrence over a user selected time frame. In addition, those alarms may be filtered for viewing per user selected options. A single selection shall display all alarms that have not been acknowledged.

H. Web Page Generation

1. Web pages shall be generated automatically from the BAS displays that reside on the BAS server. User shall access Web-page host via the network and shall initiate a web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access via any computer's standard browser. Any system that requires use of an HTML editor for generation of Web pages shall not be considered.

I. Password Security and Activity Log

1. Access via Web browser shall utilize the same hierarchical security scheme as BAS system. User shall be asked to log in once the browser makes connection to Web-page host. Once the user logs in, any and all changes that are made shall be tracked by the BAS system. The user shall be able to change only those items that the user has authority to change. A user activity report shall show any and all activity of the users that have logged in to the system regardless of whether those changes were made using a browser or via the BAS workstation.

J. BACnet Communication

1. Web server shall directly communicate to all devices on the BAS network using BACnet protocol. No intermediate devices shall be necessary for BACnet communication.

2.3 BUILDING CONTROLLER

A. General Requirements

B. Building Controller shall consist of a power supply, BACnet Ethernet-MS/TP, BACnet MS/TP, LonTalk FTT-10, and modem module for telephone communication as a minimum. Those projects that require special interfaces may use Modbus modules as needed. However, all Ethernet communications and all controllers including central plant controllers, advanced Programmable controllers and unitary controllers supplied by BMS manufacturer shall utilize the LonTalk or BACnet protocol standards.

C. All communication with operator workstation shall be via BACnet Ethernet. All communication with Programmable controllers shall be LonTalk FTT-10 or BACnet MS/TP Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and MS/TP, FTT-10 LANS. Ethernet – MS/TP, FFT module shall also route messages from all other Building Controller modules onto the BACnet Ethernet network.

1. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps.
2. The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).

D. The Building Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs) and function as a BACnet Broadcast Management Device (BBMD).

E. Building Controller MS/TP module communications shall be via BACnet master slave token passing (MS/TP) LAN. Building Controller FFT-10 module communications shall be via LONtalk

FFT-10 LAN using transceivers to all advanced Programmable and Programmable specific controllers. MS/TP module shall also route messages to Ethernet-MS/TP module for communication over WAN.

1. MS/TP LAN must be software configurable from 9.6 to 76.8Kbps
2. Configuration shall be via RS-232 connection.

F. All controllers shall be capable of providing global control strategies for the system based on information from any objects in the system regardless if the object is directly monitored by a building controller. The software program implementing these strategies shall be completely flexible and user definable. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, via a wide area network or downloaded via remote communications are not acceptable. Changing global strategies via firmware changes is also unacceptable.

G. Programming shall be object-oriented using control function blocks, supporting DDC functions, 1000 Analog Values and 1000 Binary Values. All flowcharts shall be generated and automatically downloaded to controller.

H. Provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed via the operator's workstation or field computer.

I. Controller shall have a memory needed to ensure high performance and data reliability. Battery shall provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Battery back up shall maintain real-time clock functions for a minimum of 20 days.

J. Global control algorithms and automated control functions shall execute via 32-bit processor.

K. Schedules

1. Each building controller module shall support a minimum of 80 BACnet Schedule Objects and 80 BACnet Calendar Objects.
2. Building controller modules shall provide normal 7 day scheduling, holiday scheduling and event scheduling.

L. Logging Capabilities

1. Each building controller shall log as minimum 320 values. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
2. Logs may be viewed both on-site or off-site via WAN or remote communication.
3. Building controller shall periodically upload trended data to networked operator's workstation for long term archiving if desired.
4. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

M. Alarm Generation

1. Alarms may be generated within the system for any object change of value or state either real or calculated. This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
2. Each alarm may be dialed out as noted elsewhere.

3. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site via remote communications.
4. Controller must be able to handle up to 320 alarm setups stored as BACnet event enrollment objects – system destination and actions individually configurable.

N. Demand Limiting
1. Demand limiting of energy shall be built a built in function that shall be user configurable. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
2. Load shedding programs in Building Controller Modules shall operate as defined in section 2.1.J of this specification.
3. Monitor total power consumption for each power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
4. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
5. Forecast demand (kW): Predicted by sliding window method.
6. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.
7. Demand Target: Minimum of 3 for each demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
8. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
9. Limits: Include control band (upper and lower limits).
10. Output advisory when loads are not available to satisfy required shed quantity, advise shed requirements and requiring operator acknowledgment.

O. Duty Cycling:
1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by equal quantity off portion is reduced.
3. Set and modify following parameters for each individual load.
    a. Minimum and maximum off time.
    b. On/Off time in one-minute increments.
    c. Time period from beginning of interval until cycling of load.
    d. Manually override the DDC program and place a load in an On or Off state.
    e. Cooling Target Temperature and Differential.
    f. Heating Target Temperature and Differential.
    g. Cycle off adjustment.

P. Automatic Time Scheduling:
1. Self-contained programs for automatic start/stop/scheduling of building loads.
2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
3. Special day's schedule supporting up to 30 unique date/duration combinations.
4. Number of loads assigned to time program; with each load having individual time program.
5. Each load assigned at least 16 control actions for each day with 1 minute resolution.
6. Furnish the following time schedule operations:
    a. Start.

b. Optimized Start.
c. Stop.
d. Optimized Stop.
e. Cycle.
f. Optimized Cycle.

7. Capable of specifying minimum of 30 holiday periods up to 100 days in length for the year.
8. Create temporary schedules.
9. Broadcast temporary "special day" date and duration.

Q. Start/Stop Time Optimization:
1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
2. Adaptive and self-tuning, adjusting to changing conditions unattended.
3. For each point under control, establish and modify:
a. Occupancy period.
b. Desired temperature at beginning of occupancy period.
c. Desired temperature at end of occupancy period.

R. Night Setback/Setup Program: Reduce heating space temperature set point or raise cooling space temperature set-point during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.

S. Calculated Points: Define calculations and totals computed from monitored points (analog/digital points), constants, or other calculated points.
1. Employ arithmetic, algebraic, Boolean, and special function operations.
2. Treat calculated values like any other analog value; use for any function where a "hard wired point" might be used.

T. Event Initiated Programming: Any data point capable of initiating event, causing series of controls in a sequence.
1. Define time interval between each control action between 0 to 3600 seconds.
2. Output may be analog value.
3. Provide for "skip" logic.
4. Verify completion of one action before proceeding to next action. When not verified, program capable of skipping to next action.

U. Direct Digital Control: Furnish with each control unit Direct Digital Control software so operator is capable of customizing control strategies and sequences of operation by defining appropriate control loop algorithms and choosing optimum loop parameters.
1. Control loops: Defined using "modules" are analogous to standard control devices.
2. Output: Paired or individual digital outputs for pulse width modulation, and analog outputs.
3. Firmware:
a. PID with analog or pulse-width modulation output.
b. Floating control with pulse-width modulated outputs.
c. Two-position control.
d. Primary and secondary reset schedule selector.
e. Hi/Low signal selector.
f. Single pole double-throw relay.

g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.

4. Direct Digital Control loop: Downloaded upon creation or on operator request. On sensor failure, program executes user defined failsafe output.

5. Display: Value or state of each of lines interconnecting DDC modules.

V. Fine Tuning Direct Digital Control PID or floating loops:

1. Display information:
   a. Control loop being tuned.
   b. Input (process) variable.
   c. Output (control) variable.
   d. Set-point of loop.
   e. Proportional band.
   f. Integral (reset) Interval.
   g. Derivative (rate) Interval.
2. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" versus "variable".

W. Trend logging:

1. Each control unit capable of storing samples of control unit's data points.
2. Update file continuously at operator assigned intervals.
3. Automatically initiate upload requests and then stores data on hard disk.
4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
5. Co-ordinate sampling with specified on/off point- state.
6. Display trend samples on workstation in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time versus data.

X. Tenant Activity Logging

1. Tenant Activity logging shall be supported by Building Controller Module. Each independent module shall support a minimum of 80 zones.
2. Tenant Activity logging shall functions as defined in section 2.1.K of this specification.

2.4 CENTRAL PLANT AND AIR HANDLER PROGRAMMABLE CONTROLLERS

A. Provide one or more Programmable controllers for each air handler and provide programmable controllers as needed for central plant control that adequately cover all objects listed in object list. All controllers shall interface to building controller via MS/TP or FTT-10 LAN using BACnet or LonTalk protocol.

B. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. No auxiliary controllers shall be used.

C. Communication Conformance

1. Programmable controllers shall communicate using LonTalk or BACnet MSTP, ANSI/ASHRAE Standard 135-2004 (BACnet). Controllers communicating using LonTalk shall use FTT-10 transceivers and communicate using LonMark-approved SNVTs
   a. Files Functional Group
   b. Reinitialize Functional Group

c. Device Communications Functional Group

2. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet or LonMark object types supported shall include as a minimum—Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

D. Programmable controllers shall include universal inputs with 10-bit resolution that accept 3K and 10K thermistors, 0–10VDC, 0–5 VDC, 4–20 mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of 3 inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs shall be switch selectable as either 0–10VDC or 0–20mA. Software shall include scaling features for analog outputs. Programmable controller shall include 24VDC voltage supply for use as power supply to external sensors.

E. All program sequences shall be stored on board Programmable controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal. Programming of Programmable controller shall be completely modifiable in the field over installed BACnet and LonTalk LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Programmable controller shall be programmed using programming tools.

F. Programmable controller shall include support for intelligent room sensor. Display on intelligent room sensor shall be programmable at Programmable controller and include an operating mode and a field service mode. See sequence of operation for specific display requirements at intelligent room sensor.

2.5 TERMINAL UNIT PROGRAMMABLE CONTROLLERS (Heat Pumps, AC Units, Fan Coils)

A. Provide one controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller via MS/TP LAN using BACnet or FTT-10 using LonTalk protocols. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

B. Communication Conformance

1. Programmable controllers shall communicate using LonTalk or BACnet MSTP, ANSI/ASHRAE Standard 135-2004 (BACnet). Controllers communicating using LonTalk shall use FTT-10 transceivers and communicate using LonMark-approved SNVTs

a. Files Functional Group

b. Reinitialize Functional Group

c. Device Communications Functional Group

2. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet or LonMark object types supported shall include as a minimum–Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Programmable controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, 4–20 mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of Programmable controller shall be completely modifiable in the field over installed BACnet and LonTalk LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen.

E. Programmable controller shall include support for intelligent room sensor. Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. See sequence of operation for specific display requirements at intelligent room sensor.

2.6 VAV BOX CONTROLLERS—SINGLE DUCT

A. Provide one controller for each VAV box that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller via MS/TP LAN using BACnet or FFT-10 using LonTalk protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. Programmable controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall also include binary outputs on board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA control signals. Programmable controller shall include microprocessor driven flow sensor for use in pressure independent control logic. All boxes shall be controlled using pressure independent control algorithms and all flow readings shall be in CFM (LPS if metric).

C. All program sequences shall be stored on board Programmable controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of Programmable controller shall be completely modifiable in the field over installed BACnet or LonTalk LANs or remotely via modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on

screen. Programmable controller shall be programmed using the same programming tool as Building Controller and as described in operator workstation section. All programming tools shall be provided as part of system.

D. Programmable controller shall include support for intelligent room sensor. Display on room sensor shall be programmable at Programmable controller and include an operating mode and a field service mode. See sequence for specific display requirements for intelligent room sensor.

E. On board flow sensor shall be microprocessor driven and precalibrated at the factory. Precalibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in EEPROM. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation.

F. Provide duct temperature sensor at discharge of each VAV box that is connected to controller for reporting back to operator workstation.

2.7 SENSORS and MISCELLANEOUS DEVICES

A. Temperature Sensors

1. All temperature sensors to be solid state electronic, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches about finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake and in a location that is in the shade most of the day.

B. Intelligent Room Sensor with LCD Readout

1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit, and shall allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator.
2. The Intelligent Room Sensor shall display room setpoint, room temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. Unit must have the capability to show temperatures in Fahrenheit or Centigrade.
3. Override time count down shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.
4. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list.

C. Wall Sensor

1. Standard wall sensor shall use solid-state sensor identical to intelligent room sensor and shall be packaged in aesthetically pleasing enclosure. Sensor shall provide override function, warmer/cooler lever for set point adjustment and port for plug-in of Field Service Tool for field adjustments or be capable of using Bluetooth compatible. Override

time shall be stored in Operator Workstation and be adjustable on a zone-by-zone basis. Adjustment range for warmer/cooler lever shall also be stored in EEPROM on controller.

D. Field Service Tool
1. Field service tool shall allow technician to view and modify all setpoints and tuning parameters stored in Programmable controller. In addition, technician shall be able to view status of all inputs and outputs on digital readout. Each piece of data shall have a data code associated with it that is customizable.
2. Field service tool shall plug into wall sensor and provide all the functionality specified. Operator workstation shall include the capability to disable operation of the field service tool.

E. Network Connection Tool
1. Network connection tool shall allow technician to connect a laptop to any MS/TP or FFT-10 network or device and view and modify all information throughout the entire network. Laptop connection to tool shall be via Ethernet or PTP.
2. Provide quick connect to MS/TP or FFT-10 LAN at each controller. Tool shall be able to adjust to all MS/TP and FFT-10 baud rates specified in the BACnet and LonMark standards.

2.8 Electronic Actuators and Valves

A. Quality Assurance for Actuators and Valves
1. UL Listed Standard 873 and C.S.A. Class 4813 02 certified.
2. NEMA 2 rated enclosures for inside mounting, provide with weather shield for outside mounting.
3. Five-year manufacturers warranty. Two-year unconditional and three-year product defect from date of installation.

B. Execution Details for Actuators and Valves
1. Furnish a Freeze-stat and install “Hard Wire” interlock to disconnect the mechanical spring return actuator power circuit for fail-safe operation. Use of the control signal to drive the actuators closed is not acceptable.
2. Each DDC analog output point shall have an actuator feedback signal, independent of control signal, wired and terminated in the control panel for true position information and troubleshooting. Or the actuator feedback signal may be wired to the DDC as an analog input for true actuator position status.
3. VAV box damper actuation shall be Floating type or Analog (2-10vdc, 4-20ma).
4. Booster-heat valve actuation shall be Floating type or Analog (2-10vdc, 4-20ma).
5. Primary valve control shall be Analog (2-10vdc, 4-20ma).

C. Actuators for Damper and Control Valves ½" to 6" shall be Electric unless otherwise specified, provide actuators as follows:
1. UL Listed Standard 873 and Canadian Standards association Class 481302 shall certify Actuators.
2. NEMA 2 rated actuator enclosures are. Use additional weather shield to protect actuator when mounted outside.
3. 5 year Manufacturers Warranty. Two-year unconditional + Three year product defect from date of installation.

4. Mechanical spring shall be provided when specified. Capacitors or other non-mechanical forms of fail-safe are not acceptable.
5. Position indicator device shall be installed and made visible to the exposed side of the Actuator. For damper short shaft mounting, a separate indicator shall be provided to the exposed side of the Actuator.
6. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for Butterfly Valve actuators.
7. A push button gearbox release shall be provided for all non-spring actuators.
8. Modulating actuators shall be 24Vac and consume 10VA power or less.
9. Conduit connectors are required when specified and when code requires it.

D. Damper Actuators:
1. Outside Air and Exhaust Air Damper Actuators shall be Mechanical Spring Return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.
2. Economizer Actuators shall utilize Analog control 2-10 VDC, Floating control is not acceptable.
3. Electric damper actuators (including VAV box actuators) shall be direct shaft mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or setscrew type fasteners are not acceptable.
4. One electronic actuator shall be direct shaft mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.
5. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per damper section. (See below execution section for more installation details.)

E. Valve Actuators ½" to 6"
1. Mechanical spring shall be provided on all actuators for pre-heat coil and actuators for AHU heating or cooling coil when units are mounted outside. See plans for fail save flow function: Normal Open or Normal Closed. Capacitors or other non-mechanical forms of fail-safe are not acceptable.
2. All zone service actuators shall be non-spring return unless otherwise specified.
3. The valve actuator shall be capable of providing the minimum torque required for proper valve close off for the required application.
4. All control valves actuators shall have an attached 3-foot cable for easy installation to a junction box.
5. Override handle and gearbox release shall be provided for all non-spring return valve actuators.

F. Control Valves ½” to 6”: The BAS contractor shall furnish all specified motorized control valves and actuators. BAS contractor shall furnish all control wiring to actuators. The Mechanical contractor shall install all valves. Equal Percentage control characteristic shall be provided for all water coil control valves. Linear valve characteristic is acceptable for 3-way valves 2½ inch and above.

1. Characterized Control Valves shall be used for hydronic heating or cooling applications and small to medium AHU water coil applications to 100 gpm. Actuators are non-spring return for terminal unit coil control unless otherwise noted. If the coil is exposed to the Outside Air stream then see plans for Spring Return requirement.
   a. Leakage is Zero percent, Close-off is 200psi, Maximum differential is 30psi. Rangeablity is 500:1.
   b. Valves 1/2 inch through 2 inches shall be nickel-plated forged brass body, NPT screw type connections.
   c. Valves 1/2 inch through 1-1/4 inches shall be rated for ANSI Class 600 working pressure. Valves 1-1/2 inch and 2 inches shall be rated for ANSI Class 400 working pressure.
   d. The operating temperature range shall be 0° to 250° F.
   e. Stainless steel ball & stem shall be furnished on all modulating valves.
   f. Seats shall be fiberglass reinforced Teflon.
   g. Two-way and three-way valves shall have an equal percentage control port. Full stem rotation is required for maximum flow to insure stable BTU control of the coil.
   h. Three-way valve shall be applicable for both mixing and diverting.
   i. The characterizing disc is made of TEFZEL and shall be keyed and held secure by a retaining ring.
   j. The valves shall have a blow out proof stem design.
   k. The stem packing shall consist of 2 lubricated O-rings designed for on-off or modulating service and require no maintenance.
   l. The valves shall have an ISO type, 4-bolt flange, for mounting actuator in any orientation parallel or perpendicular to the pipe.
   m. A non-metallic thermal isolation adapter shall separate valve flange from actuator.
   n. One fastening screw shall secure the direct coupling of the thermal isolation adapter between the actuator and the valve. This will prevent all lateral or rotational forces from affecting the stem and its packing O-rings.
2. Globe valves ½" to 2" shall be used for steam control or water flow applications.
   a. Valves shall be bronze body, NPT screw type, and shall be rated for ANSI Class 250 working pressure.
   b. Valves 1/2 inch (DN15) through 2 inches (DN50) with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (.1%).
   c. The operating temperature range shall be 20° to 280° F.
   d. Spring loaded TFE packing shall protect against leakage at the stem.
   e. Two-way valves shall have an equal percentage control port.
   f. Three-way valves shall a linear control and bypass port.
   g. Mixing and diverting valves must be installed specific to the valve design.
3. Globe Valve 2 ½ to 6”
   a. Valves 2-1/2 inch (DN65) through 6 inches (DN50) shall be iron body, 125 lb. flanged with Class III (.1%) close-off leakage at 50 psi differential.
   b. Valves with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (.1%).
   c. Flow type for two-way valves shall be equal percentage. Flow type for three-way valves shall be linear.
   d. Mixing and diverting valves must be installed specific to the valve design.

G. Butterfly valves

1. Butterfly Valves shall be sized for modulating service at 60-70 degree stem rotation. Isolation valves shall be line-size. Design velocity shall be less than 12 feet per second when used with standard EPDM seats.
   a. Body is Cast Iron.
   b. Disc is Aluminum Bronze standard.
   c. Seat is EPDM Standard.
   d. Body Pressure is 200 psi, -30F to 275F.
   e. Flange is ANSI 125/250.
   f. Media Temperature Range is –22F to 240F.
   g. Maximum Differential Pressure is 200 psi for 2” to 6” size.

H. Butterfly Valve Industrial Actuators

1. 1. Actuators shall be approved under Canadian Standards Association or other Nationally Recognized Testing Laboratory to UL standards. CSA Class 4813 02 or equal. Enclosure shall be NEMA 4 (weatherproof) enclosure and will have an industrial quality coating.
   a. Actuator shall have a motor rated for continuous duty. The motor shall be fractional horsepower; permanent split capacitor type designed to operate on a 120 VAC, 1 pH, 60 Hz supply. Two adjustable cam actuated end travel limit switches shall be provided to control direction of travel. A self-resetting thermal switch shall be imbedded in the motor for overload protection.
   b. Reduction gearing shall be designed to withstand the actual motor stall torque. Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.
   c. Actuator shall have a 6 ft wiring harness provided for ease in field wiring (above 1500 in-lbs). Two adjustable SPDT cam-actuated auxiliary switches, rated at 250 VAC shall be provided for indication of open and closed position. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.
   d. Actuator shall be equipped with a hand wheel for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel must be permanently attached to the actuator and when in manual operation electrical power to the actuator will be permanently interrupted. The hand wheel will not rotate while the actuator is electrically driven.
   e. The actuator shall be Analog, floating, or two position as called out in the control sequence of operation. All Analog valves shall be positive positioning, and respond to a 2-10 VDC, 4-20 mA, or adjustable signal as required. Analog actuators shall have a digital control card allowing any voltage input for control and any DC voltage feedback signal for position indication.

I. Performance Verification Test

1. Control loops shall cause productive actuation with each movement of the actuator and actuators shall modulate at a rate which is stable and responsive. Actuator movement shall not occur before the effects of previous movement have affected the sensor.
2. Actuator shall have capability of signaling a trouble alarm when the actuator Stop-Go Ratio exceeds 30%.

J. Actuator Mounting for Damper and Valve arrangements shall comply to the following:
   1. Damper Actuators: Shall not be installed in the air stream
   2. A weather shield shall be used if actuators are located outside. For Damper Actuators use clear plastic enclosure.
   3. Damper or valve actuator ambient temperature shall not exceed 122 degrees F through any combination of medium temperature or surrounding air. Appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation shall be provided as necessary
   4. Actuator cords or conduit shall incorporate a drip leg if condensation is possible. Water shall not be allowed to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point shall be avoided to prevent water from condensing in conduit and running into actuator.
   5. Damper mounting arrangements shall comply to the following:
      a. The ventilation subcontractor shall furnish and install damper channel supports and sheet metal collars.
      b. No jack shafting of damper sections shall be allowed.
      c. Multi-section dampers shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per section.
   6. Size damper sections based on actuator manufacturers specific recommendations for face velocity, differential pressure and damper type. In general:
      a. Damper section shall not exceed 24 ft-sq. with face velocity £ 1500 FPM.
      b. Damper section shall not exceed 18 ft-sq. with face velocity £ 2500 FPM.
      c. Damper section shall not exceed 13 ft-sq. with face velocity £ 3000 FPM.
   7. Multiple section dampers of two or more shall be arranged to allow actuators to be direct shaft mounted on the outside of the duct.
   8. Multiple section dampers of three or more sections wide shall be arranged with a 3-sided vertical channel (8'' wide by 6" deep) within the duct or fan housing and between adjacent damper sections. Vertical channel shall be anchored at the top and bottom to the fan housing or building structure for support. The sides of each damper frame shall be connected to the channels. Holes in the channel shall allow damper drive blade shafts to pass through channel for direct shaft mounting of actuators. Open side of channel shall be faced down stream of the airflow, except for exhaust air dampers.
   9. Multiple section dampers to be mounted flush within a wall or housing opening shall receive either vertical channel supports as descried above or sheet metal standout collars. Sheet metal collars (12" minimum) shall bring each damper section out of the wall to allow direct shaft mounting of the actuator on the side of the collar.

K. Valve Sizing for Water Coil
   1. On/Off Control Valves shall be line size.
   2. Modulating Control Valve Body Size may be reduced at most two pipe sizes from the line size or not less than ½ the pipe size. The BAS contractor shall size all water coil control valves for the application as follows:
      a. Booster-heat valves shall be sized not to exceed 4-9psi differential pressure. Size valve for 50% Valve Authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.
      b. Primary valves shall be sized not to exceed 5-15psi differential pressure. Size valve for 50% Valve Authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.

c. Butterfly valves shall be sized for modulating service at 60-70 degree rotation. Design velocity shall be 12 feet per second or less when used with standard EPDM seats.

3. Valve Mounting arrangements shall comply to the following:
   a. Unions shall be provided on all ports of two-way and three-way valves.
   b. Install three-way equal percentage Characterized Control valves in a mixing configuration with the “A” port piped to the coil.
   c. Install 2½ inch and above, Three-Way globe valves, as manufactured for mixing or diverting service to the coil.

2.9 ENCLOSURES

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

C. Enclosures shall have hinged, locking doors.

D. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 1/8” thick sized appropriately to make label easy to read.

2.10 AIRFLOW MEASUREMENT DEVICES

A. Approved manufacturers
   1. Ebtron
   2. Air Monitor Corporation
   3. Paragon Controls

B. Duct Mounted Configurations
   1. Installation applications shall conform to manufacturer’s recommended minimum and maximum velocity requirements
   2. Installation locations shall comply with manufacturer’s recommended straight lengths of duct upstream and downstream of station.
      a. Provide open parallel cell air straightener–equalizer honeycomb upstream of station, where required, to meet manufacturer’s straight length recommendations. Honeycomb and probes to be mounted in 14 ga. (minimum) galvanized steel, welded casing in 8" depth with 90º connecting flanges in a configuration and size equal to that of the duct it is mounted into
   3. Thermal type (anemometer) airflow measuring system
      a. Each probe array shall consist of one or more multi-point measuring probes and a single microprocessor based transmitter. The transmitter shall be supplied by the same manufacturer as the measuring station or probe array.
      b. Each multi-point probe shall be assembled using heavy wall anodized aluminum tubing, aluminum mounting plates, aerodynamically optimized molded sensing apertures to ensure accurate measurement in angular airflow conditions, and neoprene mounting gasket.
      c. The probe array shall be connected to the transmitter using a single cable, of up to 100' in length, included with the transmitter.

d. Each stand-alone sensing point shall use an ambient temperature thermistor and an externally heated thermistor to determine the point velocity and temperature. Automatic equal area averaging of the individual point measurements shall be performed in the transmitter.

e. Each airflow sensor shall have an operating range of 5,000 FPM, with a NIST traceable accuracy of ±2% of reading for velocity measurement and 0.1ºF for temperature measurement.

f. The number of sensors for each rectangular probe array shall be:

Station Area	Sensor Density
1 to < 15 Sq. Ft.	1.50 Sq. Ft. Per Sensor
15 to < 30 Sq. Ft.	1.67 Sq. Ft. Per Sensor
30 to < 60 Sq. Ft.	2.10 Sq. Ft. Per Sensor
60 to 100 Sq. Ft.	3.13 Sq. Ft. Per Sensor

g. Individual sensors shall be fully field serviceable without need for field calibration, not requiring that the probe be returned to the Factory for repair and/or calibration.

h. Each transmitter shall be capable of averaging as many as thirty-two (32) sensors,

i. The transmitter will have a high visibility backlit LCD for display of either the averaged or individual sensor airflow and temperature measurements, in user selectable units of measure. The transmitter shall be factory configured to output duct air volume for plug and play operation.

j. All transmitter configuration, scaling, and diagnostic functions shall be performed by means of a password protected, cover mounted membrane keypad.

k. The transmitter outputs shall be dual analog (4-20mA, 0-5VDC or 0-10VDC) for airflow and temperature or optional LonWorks® communication interface.

l. The operating temperature range of the transmitter shall be from -20º to 140ºF. The transmitter shall be located where it will be sheltered from water or weather.

m. Input power to each transmitter shall be 24VAC/24VDC.

n. When installed per the manufacturer's minimum installation requirements, the transmitter with accompanying station or probe array shall measure with an accuracy of ±2-3% of actual flow.

4. Pitot type (differential pressure) airflow measuring system

a. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probe(s), and shall be the offset (Fechheimer) type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30º. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket, and signal fittings suitable for HVAC duct installation.

b. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular ducts) or at equal concentric area centers (for circular ducts) along the probe length.

c. Probes shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of ±2% without the use of correction factors. The maximum allowable unrecovered pressure drop caused by the probes shall not exceed .025" w.c. at 2000 FPM, or .085" w.c. at 4000 FPM.

d. The Transmitter shall have an accuracy of ±0.5% of Natural Span and user selectable square root function. The Transmitter shall be housed in a NEMA 1 aluminum with universal 1/8" FPT signal connection ports. The transmitter shall be supplied by the same manufacturer as the measuring station or probe array.

C. Fan Inlet Configurations

1. Provide only pitot type air flow measuring systems for fan inlet configurations.
2. The Airflow Measuring Station shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probes and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the probe, nor be adversely affected by particle contamination normally present in building system airflows.
3. The Airflow Measuring Station shall have symmetrical averaging signal takeoffs, and shall be of aluminum construction with hard anodized finish with galvanized steel mounting hardware.
4. The Airflow Measuring Station shall not significantly impact fan performance or contribute to fan generated noise levels. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.
5. The Transmitter shall have an accuracy of ±0.5% of Natural Span and user selectable square root function. The Transmitter shall be housed in a NEMA 1 aluminum enclosure with universal 1/8" FPT signal connection ports. The transmitter shall be supplied by the same manufacturer as the measuring station or probe array.

D. Rooftop Unit Configurations with Direct inlet of Outside Air

1. This specification subsection refers to all outside airflow monitors for air handling units where outdoor air ductwork is not present (such as rooftop air handling units). For ducted outdoor airflow applications, refer either to this subsection or subsection B (Duct Mounted Configurations) above.
2. The outside air flow station shall use a technology that measures pressure drop via an outside air reference and an inlet airflow sensor across a fixed resistance element to provide 5 % accuracy for outside air under all circumstances. The Outside Reference Sensor shall be centrally positioned in, and mounted to the surface of the inlet. The Reference shall be located upstream of any inlet louver, mist eliminator, bird screen, rain hood, etc. The Inlet Airflow Sensor shall be located downstream of any inlet louver, mist eliminator, bird screen, rainhood, etc., and upstream of the outside air intake control damper(s). Outside airflow sensors that use technologies other than pressure drop (thermal or pitot tube) shall provide the means to protect the flow station from moisture and provide a means to clean to unit from dirt and debris on a continuous basis.
3. The outside air flow measuring station shall be constructed to prevent measurement instability caused by the variable presence of moisture (rain and humidity), and accuracy degradation caused by dirt build-up around flow station ports and thermal surfaces.
4. The outside airflow measuring station shall obtain accurate and repeatable measurement in the absence of any upstream/downstream straight duct run.

5. The outside air flow measuring station shall account for outside air temperature variances of 150° F installed in locations ranging from sea level to 5,000 feet elevation. The station shall make necessary temperature and altitude compensating adjustments.
6. The Outside Airflow Measurement System shall contain an integral multi-line liquid crystal display for use during the configuration and calibration processes, and to display two measured processes (volume, velocity, temperature) during normal operation. All configuration, output scaling, calibration, and controller tuning will be performed digitally in the on-board microprocessor via input pushbuttons
7. The Outside Airflow Measurement System shall measure inlet airflow with an accuracy of ±5% of reading over a range of 150-600 FPM, 250-1,000 FPM, 150-2,000 FPM, and 500-2,000 FPM and not have its reading affected by the presence of directional or gusting wind. Measured airflow shall be density corrected for ambient temperature variances, and atmospheric pressure due to site altitude.
8. The outside air flow measuring station shall be constructed to prevent measurement instability caused by the variable presence of moisture (rain and humidity), and accuracy degradation caused by dirt build-up around flow station ports and thermal surfaces.
9. The Outside Airflow Measurement System shall interface with existing building automation systems (BAS), accepting inputs for fan system start, economizer mode operation, and an external controller setpoint, and provide flow deviation alarm outputs.
10. The sensors shall be constructed of materials that resist corrosion due to the presence of salt or chemicals in the air; all non-painted surfaces shall be constructed of stainless steel. The electronics enclosure shall be NEMA 1.
    a. If the electronics enclosure is to be mounted outdoors, provide in a thermostatically controlled NEMA 4 enclosure with heater.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the owners' representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

3.2 INSTALLATION (GENERAL)

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

3.3 LOCATION AND INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units where not subject to excessive vibration. Obtain approval on locations from owner’s representative prior to installation.

B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operations.

C. Install with 120 volt alternating current, 15 amp dedicated circuit to each programmable control unit or local UPS provided by ATC.

D. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.

E. Identify all equipment and panels. Provide permanently mounted tags for all panels.

F. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections—sized to suit pipe diameter without restricting flow.

3.4 INTERLOCKING AND CONTROL WIRING

A. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 26 and all national, state and local electrical codes.

B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.

C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.

D. Provide auxiliary pilot duty relays on motor starters as required for control function.

E. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings—coordinate with electrical contractor.

F. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum rated cable (without conduit).

3.5 DDC OBJECT TYPE SUMMARY

A. Provide all database generation.

B. Displays
   1. System displays shall show all analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide outside air temperature indication on all system displays associated with economizer cycles.

C. Run Time Totalization
   1. At a minimum, run time totalization shall be incorporated for each monitored supply fan, return fan, exhaust fan, hot water and chilled water pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.

D. Trendlog
   1. All binary and analog object types (including zones) shall have the capability to be automatically trended.

E. Alarm
   1. All analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.

F. Database Save
   1. Provide back-up database for all stand-alone Programmable controllers on disk.

3.6 FIELD SERVICES

A. Prepare and start logic control system under provisions of this section.

B. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for 1 year or as specified.

D. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.7 AS BUILT DOCUMENTATION REQUIRED

A. Refer to 23 04 00GENERAL CONDITIONS FOR MECHANICAL TRADES

3.8 TRAINING

A. Provide application engineer to instruct owner in operation of systems and equipment.

B. Provide system operator’s training to include (but not limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of 3 persons.

C. Provide on-site training above as required, up to 16 hours as part of this contract.

3.9 DEMONSTRATION

A. Provide systems demonstration under provisions of Section 23 04 00.

B. Demonstrate complete operating system to owner's representative.

C. Provide certificate stating that control system has been tested and adjusted for proper operation.

END OF SECTION

SECTION 230950 – FACILITY MONITORING SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of the Contract, General Conduct of the Work and Special Requirements, and Division 1 Specification Sections, apply to this Section.

1.2 OVERVIEW

A. This document contains the specification and input/output summaries for a Facility Monitoring System (FMS). The system architecture shall utilize local room, duct and outside air probes networked to distributed Air Data Routers and Sensors Suites communicating over a data and air sampling network. The air sampling network shall consist of an air packet transportation network that shall transport air samples from the environment being monitored to distributed Sensor Suites located throughout the facility. The air sampling network shall consist of intelligent air packet routers, an electrically conductive MicroDuct® network, Structured Cable and where applicable OT Tubing. Gathering of air samples shall occur via room, duct mounted, and outside air sampling probes located as indicated in the documents.

B. The FMS shall provide continuous monitoring of environmental conditions and ventilation performance as prescribed in the Sensor Suite section. With an active FMS Services Commitment the FMS shall provide protected information access via a web based user interface to analytical summaries, system generated reports, in onscreen graphical form, system distributed reports, and analysis based notifications. Web-based utilities are to be included to export FMS data as a comma separated values (.csv) file format. The FMS shall interface with other analog and microprocessor based building subsystems as shown on the drawings, specified herein and in other sections.

C. The FMS specified herein, shall be by Aircuity, Inc., Newton Massachusetts.

D. Alternate manufacturers may bid based upon meeting all requirements of the specification and receiving approval from the engineer 30 days prior to bid. A paragraph-by-paragraph comparison of the based bid specified system versus alternative system along with three references of similar projects (include project name, contact, phone number, location, consultant, value of contract, and a brief description of the control system and how it operates) shall be submitted prior to bid for review process. Bids shall not be accepted by Alternate manufacturer if approval is not received from the engineer prior to bid. If approved, other manufacturer's bids shall be shown as an add or deduct on the bid form.

1.3 RELATED SECTIONS

A. 3rd-Party Interfacing is required on this project according to the following Specification sections for sub-systems:
   1. Section 230900 – Direct Digital Control System for HVAC

1.4 REFERENCES

A. ANSI/ASHRAE 135-2001: BACnet® - A Data Communication Protocol for Building Automation Systems: This shall include the Standard and all published Addenda.

1.5 CODES, REGULATIONS, AND COMPLIANCE

A. All electrical equipment and material and its installation shall conform to the current requirements of the following authorities:
1. Occupational Safety and Health Act (OSHA)
2. National Electric Code (NEC)
3. National Fire Code

B. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.

C. All Air Data Routers and Sensor Suites shall comply with:
1. Underwriters Laboratories UL916 for Energy Management Equipment
2. FCC Part 15 Class A
3. CE

D. All Plenum Rated OSC Structured Cable shall comply with:
1. UL CMP
2. NEC 800.51 (A)
3. NFPA 262
4. UL 910
5. FCC Part 15 Class A
6. CE

E. All Riser Rated OSC Structured Cable shall comply with:
1. UL CMR
2. NEC 800.51 (B)
3. ANSI 1666
4. UL 1666
5. FCC Part 15 Class A
6. CE

F. All OT Tubing shall comply with:
1. NFPA 90A
2. UL 94V-2
3. UL 1820

G. All Information Management Servers shall comply with:
1. FCC Part 15 Class A
2. CE

H. All Room Sensors and Duct Probes shall comply with:
1. FCC Part 15 Class A
2. CE

I. All OSI Systems Integrators shall comply with:
   1. Underwriters Laboratories UL916 for Energy Management Equipment
   2. FCC Part 15 Class A
   3. CE
   4. C-UL Listed to Canadian Standards Association
   5. C22.2 No. 205-M1983 “Signal Equipment”

1.6 DEFINITIONS

A. ADR refers to the Air Data Router

B. BAS refers to the Building Automation System. (Similar terms are: EMS, Energy Management System; BMS, Building Management System; FMS, Facility Management System; or ATC, Automatic Temperature Control.)

C. FMC refers to the Facility Monitoring System Contractor. The FMC is the Contractor responsible for the implementation of this Section of the Specifications

D. FMS refers to the hardware, software and other components comprising the Facility Monitoring System as herein described

E. I/O refers to Input/Output. Thus, "I/O device" means "Input/Output device"

F. IMS refers to the Information Management Server

G. LACS refers to the Laboratory Airflow Control System

H. OSI refers to the OSI Systems Integrator

I. PCM2 refers to a pump control module

J. SST refers to the Sensor Suite

K. OT refers to the OT Tubing

L. OSC refers to the OSC Structured Cable

1.7 ACCEPTABLE FACILITY MONITORING SYSTEM CONTRACTOR (FMC)

A. The FMC shall have support services within a 50 mile radius of Project Site and comply with the service requirements of a 24 hour response time. Any technicians working on the FMS will be certified by the FMS manufacturer for such work. Support services is defined as having access to complete parts inventory, having all required test and diagnostic equipment, and having factory certified technicians on the systems specified herein.

1.8 SUBMITTALS

A. As soon as Submittals are prepared, an electronic version shall be provided simultaneously with the mailing of the paper copies. This version shall be transmitted in electronic format, via e-mail, to expedite the approval process.

B. Shop Drawings shall include:
   1. Index: The first sheet of the Shop Drawings shall be an Index of all sheets in the set.
   2. Legend: A description of symbols and acronyms used shall be provided at the beginning of the set of Shop Drawings.
   3. Communications Riser: A single-page diagram depicting the system architecture complete with a communications riser. Riser shall include room locations and addressing for each Air Data Router and Sensor Suite. Include a Bill of Material for all equipment in this diagram but not included with the unique controlled systems.
   4. Device Addressing Scheme: Install controllers implementing an addressing scheme consistent with a reference-document. The addressing scheme shall be submitted, reviewed and approved by the owner's BAS Group prior to implementation.
   5. Equipment Numbering: Equipment numbering scheme shall be submitted, reviewed and approved by the owner's BAS Group prior to implementation.
   6. Systems Summary: Drawings shall include a table listing each piece of equipment and the area(s) served by each piece of equipment.
   7. System Schematic: Drawings shall include a single-line representation of all areas being monitored and/or controlled, including all field devices required for properly controlling equipment and implementing the sequences of operation for this project.
   8. Point-to-point Wiring Details: Drawings shall include point-to-point wiring details and must show all field devices, routers, sensor suites, controllers, panel devices, wiring terminal numbers and any special information (i.e. shielding requirements) for properly monitoring areas and controlling equipment.
   9. Bill of Material: Drawings shall include a bill of the material necessary and used for properly controlling equipment and implementing the required sequences of operation.
   10. Configuration Details: Drawings shall include test and cluster sequence schedules for each test point.
   11. As-Built Drawings and documentation shall be created after the final system checkout, by modifying and adding to the Shop Drawings and completing the FMS system vacuum decay worksheet. As-Built Drawings shall show exact installation locations of equipment as well as indicate installed cable paths and lengths. As-Built Drawings will be acknowledged in writing by the project design engineer and the owner's representative after the final checkout of the system. The system will not be considered complete until the As-Built Drawings have received their final approval. The FMC shall provide four sets of As-Built Drawings.

C. Operation and Maintenance Manuals
   1. Operation and Maintenance (O&M) manuals for the system shall include project specific, detailed information describing the specific installation. Manual shall contain as a minimum:
      a. System overview
      b. Networking architecture
      c. Hardware cut-sheets and product descriptions
      d. Wiring diagrams for all controllers and field hardware

1.9 WARRANTY

A. Repair or replace any defective product not covered by Hardware Assurance (see section 2.9.A.2 below) and correct any defect in material or workmanship for a period of 36 months following date of shipment.

1.10 SERVICES COMMITMENT AGREEMENT

A. At the time of sensors are shipped from the factory as described later in this specification, the FMC will transmit an agreement for annual services to the owner marked “PAID IN FULL” that will provide services for the system for a period of 2 years. Under this agreement the FMC will provide four services: MONITORING, SENSOR ASSURANCE, HARDWARE ASSURANCE AND REPORTING.

1. Monitoring: Monitoring is both predictive and diagnostic and evaluates the performance of the mechanical and electrical components.
    a. Data Upload: Verification is performed on every test area to ensure itis uploading correctly.
    b. System Events: The system is scanned for proper functionality and is checked for such events as leak test status and communication hardware status.
    c. Sensor Performance: All sensors have a designated life span which is why sensor performance is reviewed for a number of conditions including out of range, failure, and calibration due date. Any issues found are either solved remotely or by sending FMS certified service technicians.
2. Sensor Assurance: Sensor element replacement, calibration services, diagnostics, firmware upgrades, materials and equipment necessary for ongoing system operation. At a minimum, twice a year, provide calibration with NIST traceable calibration gases and test instrumentation, functional testing, sensor element evaluation to determine useful life and element replacement as required, and evaluation services to insure the ongoing performance of all sensors as installed system per this specification. This service shall include, but not be limited to the following:
    a. Sensor Calibration: Sensors require periodic calibration to ensure their long-term accuracy and reliable performance. All sensors undergo scheduled factory recalibration twice per year. These factory performed services include sensor calibration and a functional test of the unit based on the sensor manufacturer’s instructions. A calibration certificate is available for each sensor, which contains information on calibration settings and the values obtained during its full range of testing.
    b. Sensor Exchange: Every six months, freshly calibrated sensors will be shipped from FMS’ Calibration Laboratory to the FMS representative for installation at the Sensor Suite. The representative will exchange the calibrated sensor for the one currently in the system and return the previous sensor to the factory in the prepaid package. FMS manages this process for the life of the active system to eliminate the risk of sensor failure and the headaches of scheduling sensor exchanges.
    c. Sensor Element Replacement: The sensor element is the internal component that performs the actual sensing. Sensor elements are consumed, wear out, and/or become inactive over time as a natural part of their operation. Sensor element replacement is performed as required during the course of sensor calibration at no additional charge to the customer. As the element degrades and/or wears out over time, it is routinely replaced to assure the FMS is operating at peak performance.
    d. Sensor Hardware: The repair or replacement of any defective sensor component is covered by the hardware aspect of Sensor Assurance.
    e. Sensor Firmware: Periodic software updates are covered by the firmware aspect of Sensor Assurance.
3. Hardware Assurance: FMS is designed to be a long-term solution. Certain subcomponents of the system have a calculated life span; FMS’ Hardware Assurance will provide for the replacement of the vacuum pump, UPS and Information Management

Server. This service makes certain that the components of an FMS are operating at their peak performance for years to come.

4. Reporting: Your daily view and deeper dive on building performance are both here.
   a. Dashboard: FMS' dashboard provides a daily view of your savings, system performance and occupant behavior. Building data from other systems can be integrated through the BMS, enhancing the diagnostic capabilities of the dashboard
   b. Graphing & Exporting: This tool is used for a deeper dive into your facility's operation. See an event on your dashboard? Graphing & Exporting allows you to dig deeper into the cause. The available data can also be used for reporting and documentation purposes.

PART 2 PRODUCTS

2.1 CONTRACTOR RESPONSIBILITIES:

A. The FMC shall furnish all necessary hardware, wiring, Structured Cable, Tubing, computing equipment and software required to provide a complete and functional system necessary to perform the design intent and as defined in this specification.

B. Installation of all FMS components; and all electrical work required as an integral part of this section as noted in Part 3 Execution including but not limited to Sensor Suites, Air Data Routers, Room, Duct, and Outside Air Probes, Transformers, Vacuum Pumps, Information Management Servers, Structured Cable, and where applicable OT Tubing, etc., shall be by Division 23

C. The base price of the system will include a comprehensive Services Commitment agreement for 2 years as described in the Services Commitment agreement portion of this specification.

2.2 CONTRACTOR (FMC) EXPERIENCE AND PERFORMANCE

A. The FMC shall have a local office or representative, staffed with factory certified technicians, fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components. The FMC shall be responsible for replacement of all products supplied at all times for a period of not less than 1 year following project completion, and shall provide a 24 hour response to a service/warranty call from the owner.

2.3 SYSTEM REQUIREMENTS

A. All material and equipment used shall be standard components, regularly manufactured and available by the manufacturer and not custom designed especially for this project. All systems and components, except site specific software, shall have previously been thoroughly tested and proven in actual use prior to installation on this project.

B. The system shall have the ability to host multiple sensors for the purpose of simultaneously sensing multiple parameters from a single test area's environment.

C. The system shall provide the end user the ability to select which environmental parameters will be sensed on a test area by test area basis.

D. The system shall have the ability to make true differential measurements by utilizing the same suite of sensors to evaluate both the contaminant levels of a test area and the source of the ventilation air.

E. The system shall have the ability to perform application specific computations using sensed contaminant levels for the purposes of generating ventilation command signals to be read by a BAS or LACS via BACnet over IP connections.

F. The system shall have the ability to have third party data (i.e. supply air flow, return air flow, occupancy statuses, etc.) written to it by a BAS via BACnet over IP connections for the purposes of generating analytical data and reports based of off actual system performance.

G. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.

H. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

2.4 EQUIPMENT

A. System Hardware
1. The FMC shall provide the following:
   a. All Air Data Routers, Sensor Suites, Sensor Suite Sensors, Room, Duct, and Outside Air Probes, Information Management Servers, Vacuum Pumps, Structured Cable, OT Tubing, Transformers and when required, an OSI Systems Integrator to perform the functions listed.

B. System Software
1. The FMC shall provide all software identified in this specification. The database required for implementation of these specifications shall be provided by the FMC, including point descriptors, test sequences, reports and point summaries. The FMC shall provide and create the system using the latest software release, at the time of Shop Drawing approval.
2. The FMC shall provide a BACnet compatible integration server and software to interface with the facility's BAS. Communication shall be via BACnet over IP.

C. Building Ethernet Connection Cabling:
1. The owner shall provide CAT-5e or CAT-6 network drops and cabling between the FMS Information Management Server and:
   a. The owner's Building Ethernet Network - to serve as the path to the offsite archival and analysis system (the FMS' Knowledge Center)
   b. The owner's BACnet communications network (if different from the above) – to serve as the connection to the BAS.
2. Final Building Ethernet Connection(s) shall be coordinated with the owner's IT Group.

D. Both the FMS manufacturer and FMC shall have quality control procedures for design and manufacture of Facility Monitoring Systems for precision monitoring, indoor air quality, energy savings and preventative maintenance.

E. The FMC shall provide all zone attribute data and programming and shall coordinate object naming conventions and network map requirements with the owner's internal BAS department.

The naming convention shall be submitted with the FMC Shop Drawings for review and approval by owner's BAS department.

2.5 SYSTEM OVERVIEW

A. The purpose of the FMS is to establish with extreme precision the proper amount of ventilation needed based on analysis of the air within the facility for airborne contaminants. This analysis will involve precise comparison between air within any space being ventilated and the air being supplied to it, the air outside the building, or both as indicated in specific applications.

B. Data captured during the analysis and through the ventilation management process will be analyzed and formatted into a host of on screen displays, analytical reports, and analysis based notification of operational deficiencies. These analyses will encompass data sets gathered over time, and should not be confused with simple alarm notifications.

C. AIR DATA ROUTERS

1. The Air Data Router shall be furnished as a complete, self-contained, unit housing all electronics, air solenoid valves, sampling manifolds, firmware, and software. Unit shall be furnished with all internal devices and wiring assembled and tested at the factory.
2. The Air Data Router shall feature backbone connections capable of accepting OSC Structured Cable for the purpose of daisy chaining all ADRs.
3. Air Data Routers shall receive commands from the Sensor Suite to open the solenoid valve of each test area to be monitored while simultaneously closing all other solenoid valves in the system. A direct path between the test area being sampled and the virtual sensors located with the Sensor Suite shall be established to draw a continuous stream of air through the OSC.
4. Air Data Routers shall consist of an enclosure; terminations areas for both field wiring and Structured Cable; a communications/processor board; high capacity solenoid valves; and sampling manifold.
5. Air Data Router shall have the ability to interface to either the FMS Structured Cable. Air Data Router shall utilize an internal, factory pre-assembled air sampling manifold to interface to the on-board solenoid valves, and push to connect speed fittings for ease of interface to the Structured Cable. Romex connectors and knockouts shall be factory furnished and installed on the Router.
6. Air Data Routers shall be capable of sampling of up to four zones.
7. Air Data router shall be capable of accepting universal 0−10Vdc or 4−20mA inputs and outputs through expansion boards for interfacing to other third party devices and controllers.
8. Up to 30 Air Data Routers shall communicate on an isolated RS-485 network with the Sensor Suite.
9. All point data, algorithms and application software within the Air Data Routers shall be programmable from the Information Management Server. Each Air Data Router shall contain both software and firmware to receive and perform full test sequencing schemes downloaded from the Server.
10. Each Air Data Router shall contain a serial port for the interface with a portable computer. Air Data Router and network integration shall be possible through this port.
11. Air Data Routers shall be capable of proper operation in an ambient temperature environment of 40 degrees F to 120 degrees F (4.4°–49°C), 0–90% RH (non-condensing).
12. Air Data Routers shall have LED indication for visual status of communication and power.

13. Air Data Routers shall operate on 24Vac power fed from a common 120/24Vac transformer. Low voltage power shall be distributed to the Air Data Routers through the associated Structured Cable or Tubing.

D. SENSOR SUITE

1. The Sensor Suite shall be a distributed, network based, multipoint sensing device. The Sensor Suite shall be furnished as a complete, self-contained unit housing all electronics, sensing card cage, sampling manifolds, flow regulators, pressure regulators, firmware, and software.
2. The Sensor Suite shall provide communications between the Air Data Router sub network and the Information Management Server over an isolated RS-485 network. The Sensor Suite shall support communications with a sub network of 30 Air Data Routers; 30 other Sensor Suites, and an Information Management Server.
3. The Sensor Suite base unit shall consist of an enclosure; hinged door with keyed lock; terminations area for both field wiring and Structured Cable subnet connections for limb A and B; a communications/processor board; electronic flow measurement and controller assembly; and sensor bay.
4. The Sensor Suite shall utilize a card cage to allow for the ease of selection and installation of a diverse array of environmental and specialty sensors. At a minimum, the Sensor Suite shall incorporate the following sensors to meet the required applications:

Sensor Specifications: Carbon Dioxide

Model Number	SEN-CO2-2B
Typical Application	CO2 Based Demand Controlled Ventilation (DCV) or Monitoring
Sensor: Carbon Dioxide (CO2)	
Element	Dual Wavelength, Non-Dispersive Infrared Sensor
Range	0–3000 ppm
Accuracy	± 75 ppm up to 1000 ppm
Repeatability	± 9 ppm
Resolution	3 ppm
Response	10 seconds

Sensor Specifications: Dewpoint/Relative Humidity

Model Number	SEN-DPT-2
Typical Application	Dewpoint Temp, Relative Humidity*, Enthalpy*, Monitoring or Control
Sensor: Dewpoint Temp (DPT)	
Element	Capacitive Polymer Sensor
Range	0 to ambient DPT Deg F or 70 Deg F, whichever is less
Accuracy	Dewpoint: ± 2 Deg F RH: @ 65°F and ± .5°F ± 6% RH @ 10−60% RH ± 8% RH @ 61−90% RH
Response	30 seconds

**Relative Humidity and Enthalpy measurements are computed from dewpoint and drybulb temperatures. Therefore, a local drybulb temperature sensor is additionally required via a room sensor, duct probe or outdoor air probe*

Sensor Specifications: Total Volatile Organic Compounds

Model Number	SEN-TVC-1&2	
Technology	MOS/PID	
Typical Application	Combines the MOS and PID sensing technology into a single assembly, while supporting the individual sensing capabilities of each. This configuration is recommended for monitoring only or for control of critical spaces such as research labs.	
Sensor: TVOCs		
Technology	MOS	PID
Element	Metal Oxide Semiconductor (MOS)	Photoionization Detector (PID)-VOCs & other gases with ionization potentials <10.6eV
Range	Calibrated Range: 0−50 ppm (as Isobutylene) Maximum Range: 0−100 ppm (as Isobutylene)	Calibrated Range: 0−5 ppm (as Isobutylene) Maximum Range: 0−20 ppm (as Isobutylene)
Accuracy	± .5 ppm (as Isobutylene) or 25% of reading (whichever is greater)	± .2 ppm (as Isobutylene) or 2.5% of reading (whichever is greater)

Resolution	0.2 ppm	0.025 ppm
Drift Stability	± 15 ppm/6 months @ 50 ppm	± 2 ppm/6 months @ 5 ppm
Response	30 seconds	30 seconds

3. The Sensor Suite shall have the ability to "multitask" by concurrently drawing an air sample from one limb while sensing the parameters of the air sample in the other limb.
6. The Sensor Suite shall be modular in nature, and allow for the addition and removal of the sensors for application specific sensing requirements, and ease of calibration and service.
7. The Sensor Suite shall house an on-board flow regulator, orifice plate, and differential pressure sensor to maintain a continuous, regulated flow rate through the Structured Cable.
8. On-board diagnostics shall continuously perform system checks.
9. The Sensor Suite will continuously monitor atmospheric pressure and compensate sensor outputs accordingly as the atmospheric pressure changes.
10. Each Sensor Suite shall contain a serial port for the interface with a portable computer. Sensor Suite and network integration shall be possible through this port.
11. Sensor Suites shall be capable of proper operation in an ambient temperature environment of 40 degrees F to 120 degrees F (4.4°–49°C), 0–90% RH (non-condensing).
12. Sensor Suites shall have LED indication for visual status of communication and power.
13. Sensor Suites shall operate on 24Vac power fed from a common 120/24Vac transformer connected to the Sensor Suite provided by the FMC.
14. To mitigate the potential for Sensor Suite failure, the Sensor Suite shall not be mounted to the same support structure as the vacuum pumps.

E. HIGH FLOW VACUUM PUMP

1. EACH Sensor Suite will be equipped with a High Flow Vacuum Pump (HFP) that will draw samples from the sampling ports in the system, through the Sensor Suite, and then discharge them. Samples will be discharged into the pump room.
2. EACH Sensor Suite will be provided with a Pump Control Module (PCM) card for monitoring system vacuum pressure and, for systems featuring dual pump systems, controlling automatic pump switchover upon primary pump failure.
3. The HFP will meet the following specifications:
   a. Minimum Vacuum Pressure: -8.5 PSIg
   b. Minimum Flow Rate: 29 LPM (1.02 SCFM)
4. Pump mounting: Pump shall be mounted securely using the factory supplied mounting assembly to prevent it from moving due to vibration, and in a location where the sound of the pump will not be heard outside the immediate area. The pump mounting assembly shall not be secured to the same structure as the IMS or Sensor Suite.
5. Standby pump with automatic switchover: Provides a second pump, identical to the first, with an automatic switchover controller that will automatically take over should the on-line pump stop for any reason other than a complete failure of all local AC power. In the event this occurs, or if some other event occurs resulting in a loss of vacuum at the SST, the standby pump will be placed in operation and a notification will be sent to the FMS' remote data center, notifying customer support that the backup pump is in operation, prompting a field visit. At any point, if there is a sustained loss of vacuum at the SST, a notification will be sent to the FMS' remote data center, and all BACnet points whose integrity is affected by the loss of vacuum condition will be marked as "unreliable", which can be observed by the BMS, so that they can respond

accordingly. The notification will be reset once the loss of vacuum condition is remedied.

F. INFORMATION MANAGEMENT SERVER

1. The Information Management Server (Server) shall provide network management of Sensor Suites, integration to the BAS, and interface to the web based FMS' Reporting portal for viewing and outputting graphs, charts and data derived from the Ventilation Management System.
2. The hardware platform for the Server shall, at a minimum, consist of:
   a. PC processor with minimum 64-bit word structure.
   b. Minimum 1.86 GHz processor speed.
   c. Minimum 2GB on board RAM
   d. Hard drive or equal high-speed data storage, minimum 250 gigabytes.
   e. Two (2) Gigabit LAN connections: (10/100)
   f. Dual RS-232 Serial Ports
   g. Operating System shall be Windows 7.
3. Information Management Server includes an Uninterruptable Power Supply capable of sustaining the IMS power for a minimum of 5 minutes to accommodate cycling from normal to emergency power and back.
4. The owner shall provide CAT-5e or CAT-6 network drops and cabling between the FMS Information Management Server and:
   a. The owner's Building Ethernet Network - to serve as the path to the offsite archival and analysis system (the FMS' Data Center)
   b. The owner's BACnet communications network (if different from the above) – to serve as the connection to the BAS.
   c. Final Building Ethernet Connection shall be coordinated with the owner's IT Group.
5. The Server shall be located within 25 feet of the nearest Sensor Suite and be connected to the Server through the RS-232 serial port.
6. To mitigate the potential for hard drive failure, the IMS shall not be mounted to the same support structure as the vacuum pumps.

G. OSC STRUCTURED CABLE

1. The FMS shall utilize a pre-engineered system of Structured Cable to facilitate network wide communications, distribution of low voltage power to Air Data Routers and Sensor Suites, and provide a sampling conduit for air samples all within a single cable.
2. The cable shall contain the necessary wires to distribute communications, data and low voltage power throughout the FMS. As a minimum, Structured cable shall consist of:
   a. Communications – 22 AWG twisted shield pair with drain wire
   b. Low Voltage Power – 18 AWG, 3 wire
3. An inner pathway, MicroDuct, shall be furnished as an integral part of the OSC Structured Cable to facilitate collection of zone air samples. MicroDuct shall be lined with a smooth, electrically conductive, chemically inert surface to insure air samples remain pure and uncorrupted and do not adhere to the wall lining during transport. Aircuity OSC or stainless steel tubing only. No exceptions. Polyethylene tubing, copper tubing, galvanized pipe are not acceptable. See below for stainless steel specifications.
4. Structured Cable shall not require any specialized tools for installation. Installation of the cable shall follow traditional local area network practices.
5. Structured Cable shall carry incremental length markings (in feet) throughout the cable length.
6. The minimum length of Structured Cable run between an ADR test area connection and an end device shall be no shorter than 20 feet.

7. Alternate provision for furnishing Structured Cable shall be to furnish :
   a. A dedicated air sampling network interconnecting the Air Data Routers, Sensor Suites, and room/duct sensors consisting of Type 304 Stainless Steel Welded Tubing 5/16" OD, .273" ID, .020" Wall. Compression fittings and couplings shall be used and be a minimum of Type 304, or 316L Stainless Steel. Traditional copper, plastic tubing, or variants thereof used in pneumatic controls or other processes shall not be acceptable.
   b. Dedicated wiring specifically used for the FMS consisting of a minimum of:
      1) Communications – 22 AWG twisted shield pair with drain wire
      2) Low Voltage Power – 18 AWG, 3 wire

H. ROOM, DUCT, and OUTSIDE AIR PROBES
1. Room Sensors:
   a. A semi-flush mounted, sampling port with an optional integral temperature sensor housed within one enclosure; the port within the enclosure will accept the MicroDuct from the Structured Cable.
   b. Temperature Sensing Element:
      Platinum RTD: range -30–130°F (-34–54°C)
      Accuracy: ± 0.30 °F (± .17°C)
   c. Internal coarse filter to screen out large particulate matter from entering the MicroDuct.
2. Duct Probe – Duct and Outdoor Air Mount
   a. A duct air sample probe is to be mounted within one enclosure. Duct sample probe to accept integral MicroDuct from Structured Cable.
   b. Temperature Sensing Element:
      Platinum RTD: range -30–130°F (-34–54°C)
      Accuracy: ± .30 °F (± .17°C)
   c. Internal coarse filter to screen out large particulate matter from entering the MicroDuct.
   d. Outdoor Air Locations – A NEMA 4X weatherproof enclosure shall be provided.
3. Outside Air Probe
   a. A duct temperature sensor and air sample probe is to be mounted within one enclosure. Duct sample probe to accept integral MicroDuct from Structured Cable.
   b. Internal coarse filter to screen out large particulate matter from entering the MicroDuct.
   c. NEMA 4X Weatherproof enclosure
   d. Probe is to be mounted in a location where it will not be exposed to direct sunlight.

I. Sensors:
1. Sensors are the property of the manufacturer whose warranty is covered under the Services Commitment agreement.
2. Sensors shall be installed in a listed enclosure (the Sensor Suite) in a climate controlled environment which is maintained between 40°F–120°F and 0–90% RH (non-condensing).
3. Quality of sensors: All sensors shall possess the properties published in section 2.5-B.4 of this specification. For each set of installed sensors a certificate of calibration shall be made available for viewing on each project's web based FMS Knowledge Center.
4. Sensors shall be physically removed from the sensor suite, and replaced with freshly calibrated sensors a minimum of every 6 months after the initial sensor installation.

5. Immediately after replacement, sensors are to be shipped back to the manufacturer in the postage paid return box provided by the manufacturer.

2.6 SYSTEM SOFTWARE OVERVIEW

A. The FMC shall provide all software required for configuration, operation and commissioning of the FMS system specified herein. All functionality described herein shall be regarded as a minimum. The FMC shall provide the following as a minimum:
1. Completed database.
2. Configuration of all Air Data Router, Sensor Suite, Server and user interface application programs.
3. All Configuration Tools, and all software licenses, required to configure and operate all products installed on this project.
4. The ability to override raw sensed data for the purposes of commissioning the system after integration with a BMS.

B. SYSTEM CONFIGURATION
1. Database Creation and Modification. All changes shall be done utilizing standard procedures. The system shall allow changes to be made at the local site through the Information Management Server.

C. WEB BASED USER INTERFACE AND DATA MANAGEMENT SYSTEM
1. Included with the system shall be a fully integrated web based user interface and data management system. The data management system shall be password protected and shall be able to store sampled data from all zones for online viewing and reporting.
2. The data management system will be sized to record and retain every sample taken by the system, along with other data gathered from other systems or direct interface points. The current calendar year plus two previous complete calendar years will be accessible in an active high-performance database. All data older than that will be archived and made available upon request.
3. Unlimited data access, viewing, report generation and remote data storage shall be provided with the FMS for the duration of the project commissioning and for the entire warranty period.

D. ANALYTICAL INFORMATION SERVICES
1. The FMS will be installed and configured to integrate with an offsite analytical system that will perform detailed analysis of ventilation performance and other operating conditions based on analysis of data gathered over time.
2. At the start of the Warranty period the FMC will transmit to the owner an agreement marked “PAID IN FULL” that will provide these services for a period of 2 years.
3. Access to the analytical data will be via a secure website. The offsite analytical system will also send automated notifications and summary reports to a user defined e-mail distribution list. These notifications will be issued based on the time based analysis, and should not be confused with simple alarm messages.
4. The FMS, via the secure website, will store ALL samples measured by the system. The operator will be able to select any period in time, from the time the system was brought on line until the present, to review data from any or all of the zones.
5. Graphical Analysis
   a. The operator will be able to select any period of time, from as little as 24 hours, to the entire life of the system, in order to review the data sampled by the system. The operator will be able to select any or all zones for review.

b. Each of the measured variables of the zone will be displayed on separate graphs. It shall also be possible to display certain multiple variables (for example: FMS zone-level multi-parameter DCV command and that zone's resulting Supply flow feedback) on a single graph.

c. The operator will be able to zoom in to a portion of the graph (up to a 24hr. time period) from a more detailed look at a specific period of time.

6. Export capability

a. The operator will be able to select any period of time, from as little as 24 hours, to the entire life of the system, for any and all zones, and extract any of the measured parameters (TVOC, Particulate, etc.) from the database and store them on the requesting computer. Data extracted will be stored initially in a .csv file format.

PART 3 EXECUTION

3.1 GENERAL

A. Install all equipment and systems specified herein in accordance with the manufacturer's most current version of the installation guide. In the event of conflicting information between this document and the installation guide, the most stringent requirement shall apply.

B. Verify that mechanical and control systems are complete and ensure that the systems are capable of being started and operated in a safe and normal condition before attempting to operate the FMS.

C. Install software in the Management Server. Implement all features of programs to specified requirements and as appropriate for sequence of operation.

D. Connect and configure equipment and software to achieve sequence of operation specified.

3.2 WIRING INSTALLATION

A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications.

B. All wiring shall be installed neatly and professionally, in accordance with requirements of applicable Specification Division 26 section and all national, state, and local electrical codes. All the wiring shall be installed in accordance with the current National Electrical Code (NEC).

C. Provide wiring as required by functions as specified and as recommended by equipment manufacturer to serve specified control functions.

D. Install wiring and cables according to Division 26 section and as follows:

1. Bundle and harness multi-conductor cable in place of single cables where several cables follow a common path.
2. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

E. All exposed control wiring and control wiring in the mechanical, electrical, telephone, and similar rooms shall be installed in raceways. All other wiring shall be installed neatly and inconspicuously.

F. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Both conduit and plenum wiring shall be supported from or anchored to structural members. Conduit or plenum wiring supported from or anchored to piping, duct supports, the ceiling suspension system, is not acceptable. Wiring buried in slab-on-grade concrete or explosion-proof areas shall be in rigid metal conduit. Provide adequate strain relief for all field terminations.

3.3 FIELD DEVICE INSTALLATION

A. All room probes shall be mounted so as to be accessible in accordance with ADA Guidelines, unless otherwise noted on the drawings.

B. Freestanding enclosures and panels shall be supported on steel unistrut frames, or approved equal, and be securely anchored to the floor and be well braced.

C. Enclosures and panels mounted directly to the wall shall be provided with all clearances required by the manufacturer’s installation guide.

D. A minimum of 3' working clearance shall be provided in front of all enclosures and panels; clearance shall be ensured to permit the enclosure door to open at least 90° from its closed position.

E. Mounting height shall be a maximum 6'-6" to the top of the Sensor Suite enclosure.

F. All field devices shall be installed in a location which is easily accessible after installation for the purposes of troubleshooting & future modifications.

G. IMSs and SSTs shall not be installed on the same support structure or wall as the vacuum pump bracket.

3.4 CONTROL POWER

A. Class 2 step-down transformers shall provide 24VAC power for all Air Data Routers, Sensor Suites, and associated FMS components from nearest electrical power panel noted below or as indicated on the electrical drawings—coordinate the installation and location thereof with Electrical Contractor and all other trades.
   1. The primary side of all Class 2 step-down transformers shall be fed by dedicated branch circuits with grounding conductors from the nearest building electrical distribution power panel. Branch circuits shall be installed per local state and federal codes by a licensed electrician.
   2. The secondary side of all class 2 step-down transformers, used for the purposes of providing power to Air Data Routers, Sensor Suites and associated FMS components, shall not be grounded.
   3. The IMS shall be powered from the battery backup side of the UPS shipped with every IMS. The UPS shall be powered from a 120VAC dedicated power receptacle installed per local state and federal codes by a licensed electrician.
   4. Where applicable, all FMS equipment shall be powered by the same source of emergency power as the air handling units and BAS themselves. For example, if the Air

Handling units are served by the building's generators, the FMS must also be served by the generators.

3.5 IDENTIFICATION

A. The FMC shall label each system device with a point address or other clearly identifiable notation inside the device cover - labels shall be permanent and typewritten. Use of handwritten labeling with markers is not acceptable. All FMS equipment shall be clearly identified as noted on the approved submittals.

3.6 FINAL INSTALLATION OF CRITICAL SENSORS

A. Sensors will be held at the manufacturer's location and not shipped to the site until checkout & startup of the all other portions of the FMS is complete, and mechanical systems are operational and ready to implement the sequences that will result in ventilation being performed on demand as indicated by the FMS.

B. At the time sensors are shipped the F Services Commitment agreement marked PAID IN FULL described above will be transmitted to the owner.

3.7 ACCEPTANCE OF COMPLETED FMS INSTALLATION

A. Upon completion of the installation, the FMC shall initiate the Optimization phase of the start-up process for the FMS and perform all necessary calibration, testing, and debugging operations including, but not limited to, the vacuum decay test. An acceptance test shall be performed by the FMC in the presence of the design engineer, job site project manager, and owner's representative. Acceptance test shall be scheduled with at least 10 working days advance notice. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections.

B. After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.

C. Demonstrate compliance with specifications, including calibration and testing, and air sampling test sequences. Adjust, calibrate, and fine tune equipment to achieve sequence of operation specified.

D. The acceptance test shall include, but not be limited to:
   1. The FMC shall verify the proper operation of all input/outputs.
   2. The FMC shall verify all inputs meet or exceed manufacturer's stated tolerances for accuracy.
   3. The FMC shall verify that all on-line graphical displays of air sampling test data accurately represent the real time state of the field conditions.
   4. The FMC shall verify the reliability of all communications of all Air Data Routers and Sensor Suites.
   5. The test shall include functional verification of all interfaces and system integration required to meet the scope of this project.
   6. Participation in a joint session with the BAS contractor to demonstrate that the complete sequence of operation is being executed accordingly.

E. Acceptance: When the field test procedures have been successfully demonstrated to the design engineer, job site project manager, or owner's representative and the system performance is

deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty. At this time, a "notice of completion" shall be issued by the owner's representative and the warranty period shall start.

3.8 TRAINING

A. The FMC shall provide factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of the system. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The training shall be specifically oriented to the system and interfacing equipment installed.

B. Instructions shall include 2 parts, the "New Equipment Orientation" and the "Product & Service Training".

C. New Equipment Orientation: A "walk-through" session shall include showing where all field equipment is located throughout the area involved in the project.

D. Product & Service Training: Train on-site personnel on the navigation and interpretation of the data and information provided by the system.
   1. Train personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
   2. Provide operator training on modification of data display, zone descriptors, executing commands, resetting default values, and requesting reports.

END OF SECTION

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes sequence of operation for:
1. Air terminal units.
2. Boiler plants.
3. Cabinet unit heaters.
4. Central fan systems.
5. Chillers plant.
6. Domestic hot recirculating pumps
7. Emergency generator monitoring
8. Fans
9. General alarm status monitoring.
10. Heating coils.
11. Leak detectors.
12. Miscellaneous controls as shown on the drawings.
13. Radiation.
14. Refrigeration systems.
15. Rooftop units.
16. Smoke dampers.
17. Space sensors.
18. Unit heaters.

B. Related Sections:
1. Section 01 91 13 – General Commissioning Requirements
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 08 00 - Commissioning of HVAC Systems
4. Section 23 09 00 - Direct-Digital Control System for HVAC: For equipment, devices, system components, and software to implement sequences of operation.
5. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate mechanical system controlled and control system components.
1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
2. Submit flow diagrams for each control system, graphically depicting control logic.
3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 GENERAL

A. Provide all controls, low voltage control wiring and accessories necessary to accomplish the sequence of operation as indicated below. Power wiring and interlock wiring shall be provided in accordance with Division 26 wiring requirements.

B. All sequences shall be performed by the Building Management System (BMS) unless noted as a being controlled locally or specifically noted as controlled by other systems.

C. Coordinate control sequences and setpoints with balancing and testing scope of work – refer to Section 23 05 93.

3.2 CONTROL DEVICES

A. All devices, sensors and setpoints shall be adjustable. BMS shall display setpoints and actual conditions of all control devices and position of all actuators at the central personal computer (PC).

3.3 REFRACTOMETER FOR GLYCOL

A. BMS shall monitor glycol refractometers.

B. BMS shall alarm when % glycol is below setpoint.

3.4 GLYCOL/WATER SOLUTION MAKEUP

A. BMS shall monitor pressure transmitter and activate glycol pump if pressure is below set point.

B. BMS shall monitor general alarm output at each glycol makeup unit.

3.5 CHILLERS AND PRIMARY CHILLED WATER (CHW) PUMPING SYSTEMS

A. Operation of Chillers. Chiller Plant shall be enabled when the outside air temperature rises above 55°F (adjustable). Minimum ON/OFF times will prevent short-cycling of chillers and pumps. When chiller plant is enabled, lead secondary chilled water pump shall start (see Secondary Pumping Systems Description below).
   1. When a chiller is enabled, respective primary chilled water pump shall start and control valve shall open. Chiller shall not start until flow is proven through respective flow switches. If flow status is not proven, lead chiller shall not be energized, lag chiller shall be energized and an alarm shall be activated at the central PC. Pumps are equipped with VFD's for balancing purposes only.
   2. Chillers shall be sequenced as required to maintain desired set point through a lead/lag array. Alternation of chiller lead/lag designation shall be based on operator defined run times. Lag chiller shall be activated if OA temperature is above 85°F. Also, BMS shall monitor chiller control panel for demand to start lag chiller.

3. Each chiller shall stage through its internal controls to maintain chilled water supply setpoint. Chiller shall monitor CHW return temperature to determine staging.
4. Shut down: When chiller is de-energized, respective pumps shall continue to run for 5 minutes and then turn off. Pumps shall not stop until confirmation that respective chiller's compressor has shut down (chiller stop confirmation).
5. CHW supply temperature setpoint shall be reset based upon position and demand at each CHW valve. If no zone is in the maximum cooling position, the CHW supply temperature setpoint is increased. This reset function is based on the following operator changeable variables. They are:
   a. The length of time between reset adjustments.
   b. The decrease in CHW supply temperature setpoint that is desired when the CHW valve its maximum open position.
   c. The increase in CHW supply temperature setpoint that is desired when none of the CHW valves are in a maximum open position.
   d. Demand for dehumidification.

B. Chiller Demand Limiting: Chiller sequencing through chillers or BMS shall be capable of monitoring and reducing peak power demand through the limiting of chiller system capacity.

3.6 BOILERS AND PRIMARY HOT WATER (HW) PUMPING SYSTEMS

A. Operation of Hot Water Boilers. The boiler system shall be enabled when the outside air temperature falls below 65°F (adjustable). A PID control loop, comparing the actual hot water supply temperature to its set point, shall enable/disable the boiler operation to achieve set point target. Minimum ON/OFF times will prevent short-cycling on the boiler. When boiler system is enabled, lead secondary hot water pump shall start (see Secondary Pumping Systems Description below).

B. Boiler Controller provided with boilers (refer to Specification Section 23 53 32) shall stage boilers and be capable of resetting hot water supply temperature based upon outside air temperature. BMS shall monitor boiler controller through Bacnet interface.

C. BMS shall monitor hot water supply and return temperatures in addition to Bacnet interface readings from boiler controller.

D. Primary hot water pumps shall be energized when their respective boiler is enabled (through the Boiler controller). When the respective boiler is de-energized, the pump shall continue to run for 5 minutes and then turn off. When pump status is proved, the respective boiler shall start. If status is not proved, the boiler shall not be energized and the next boiler in sequence shall energize. An alarm shall then be sent to the central PC.

E. When the boiler is enabled, the boiler status determines if the boiler is on. After an operator definable feedback time delay, if there is no positive status, an alarm shall be generated at BMS and second boiler will be enabled. Conversely, if status is detected when the boiler is turned off, a separate alarm shall be generated. All alarms shall be sent to the central PC. .

F. Hot Water Temperature Control: The operator can define the hot water supply temperature setpoint to operate within maximum and minimum values. The operator shall be able to select between any of the following three methods of determining the setpoint at any time:
1. Fixed but manually changeable by the operator.
2. Reset by an operator changeable schedule based on outside air temperature.

3. As the building approaches unoccupied time and outdoor temperatures are within set limits, the boiler temperature setpoint can be lowered per an operator definable limit in order to save heating energy.
4. Requirements of the zone's HW valve in the maximum open position, the HW supply temperature setpoint is increased to provide additional heating capacity. If no zone served by the boiler is in the maximum heat position, the HW supply temperature setpoint is decreased. This reset function is based on four operator changeable variables. They are:
   a. The length of time between reset adjustments.
   b. The increase in hot water supply temperature setpoint that is desired when the HW valve of a reheat reaches its maximum open position.
   c. The decrease in hot water supply temperature setpoint that is desired when none of the HW valves are in a maximum open position.
   d. A high limit on the rate of hot water supply temperature setpoint increase.

3.7 SECONDARY PUMPING SYSTEMS (HOT WATER)

A. Lead hot water pump shall start per sequences of operation described above. BMS shall monitor downstream hydronic differential pressure transmitters compared to user defined setpoints and modulate the pump VFD in order to maintain desired setpoints. VFD ramp-up and VFD ramp-down timing shall be user defined. Should the BMS be unable to maintain DP setpoint with the pump operating at minimum speed, the BMS shall modulate the differential bypass valve to maintain system DP.

B. Designation of lead and standby pump shall be automatically alternated based on user defined run times or day of the week.

C. When the pump is enabled, the pump VFD status determines if the motor is operating. After an operator definable feedback time delay, if there is an indication that the pump is not operating, the standby pump shall be enabled and an alarm shall be generated. Conversely, if status is detected while pump is turned off, a separate alarm shall be generated.

3.8 AIR HANDLING UNITS (RTUs)

A. Unoccupied Mode:
   1. Outside air, exhaust air and relief air dampers shall be closed.
   2. Return air dampers shall be open.
   3. Fans and energy recovery motors shall be deactivated.
   4. BMS shall raise the zone temperature cooling setpoint to 85°F and drop the zone temperature heating setpoint of 65°F. If two or more zones are calling for heating for more than 5 minutes(adj.) with space perimeter radiation valve full open or cooling the fans shall cycle on. When the call for heating or cooling is satisfied the fans shall be deactivated.
   5. Chilled water and hot water valves shall be closed.
   6. Freezestat and temperature sensor within the unit’s casing shall be monitored during unoccupied mode. If temperature drops below setpoint of either device, the main heating valve shall be fully open, fans shall be de-activated and an alarm shall be activated at the central PC.

B. Occupied Mode:
1. The zone will calculate how long it will take to return from its unoccupied state to its occupied setpoint based on the heating or cooling capacity and the outside air temperature. The zone will then adjust its effective setpoint at the time necessary in order to ensure the desired zone conditions at occupancy.
2. The system will not start more than 4 hours before a scheduled occupancy.
3. BMS shall track the supply fan's accumulated runtime. When runtime exceeds 10,000 hours, the controller will generate a runtime expiration message.
4. Fans shall operate continuously. Speed of duplex fans shall operate in unison.
5. Energy recovery motors shall be energized
6. Outside air and relief air dampers shall be at minimum open positions. Coordinate setpoints of motorized dampers serving outside air and relief air dampers with air balancer.

C. Fan Control:
1. When called to run, the fan will run for a minimum of 5 minutes.
2. When the fan cycles off, it will remain off for a minimum of 5 minutes.
3. The BMS shall modulate the speed of the supply fan to maintain the supply pressure setpoint. The speed of the return fan shall track the supply fan speed with an offset of -5% (adj.).

D. Alarm Conditions:
1. Current sensing relays/VFD feedback: If fan has been signaled to start and feedback from respective relay or VFD does not indicate the fan has started after 30 seconds, unit shall be shut down and an alarm shall be activated at the central PC. Conversely, if fan on status is detected while the fan is turned off, a separate "Hand" alarm shall be activated at the central PC .
2. Damper end switches: If end switch does not indicate respective damper is open after 30 seconds, unit shall be shut down and an alarm shall be activated at the central PC. Conversely, if a damper is indicated open, a separate "Hand" alarm shall be activated at the central PC.
3. Duct mounted smoke detectors: When a detector is in alarm mode the fire alarm system shall be notified, respective fans shall be de-energized and an alarm shall be activated at the central PC.
4. If a freezestat trips, the hot water valve at the respective unit shall be fully open, fans shall stop, outside air damper shall be fully closed and an alarm shall be activated at the central PC.
5. The controller will generate an alarm if the zone temperature remains 4°F higher than its cooling setpoint for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
6. The controller will generate an alarm if the zone temperature remains 4°F lower than its heating setpoint for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
7. The controller will generate an alarm if the discharge air temperature remains higher than 120°F with a hysteresis of 5°F for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
8. The controller will generate an alarm if the discharge air temperature remains lower than 45°F with a hysteresis of 5°F for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.

E. Supply Air Temperature Setpoint Control
   1. BMS will run a cooling setpoint optimization algorithm and a heating setpoint optimization algorithm simultaneously.
      a. The initial cooling setpoint will be 55°F, with a minimum of 53°F and a maximum of 72°F.
      b. If any zones are still calling for cooling at the end of a 5 minute period, the setpoint algorithm will respond by lowering the setpoint by 1°F for every zone requesting cooling.
      c. If no zones are still calling for cooling at the end of a period, the setpoint algorithm will respond by raising the setpoint by 1°F.
      d. The cooling setpoint algorithm will not adjust the cooling setpoint by more than 2°F in any period.
      e. The initial heating setpoint will be 82°F with a minimum of 72°F and a maximum of 85°F.
      f. If any zones are still calling for heating at the end of a 5 minute period, the setpoint algorithm will respond by raising the setpoint by 2°F for every zone requesting heating.
      g. If no zones are still calling for heating at the end of a period, the setpoint algorithm will respond by lowering the setpoint by 1°F.
      h. The heating setpoint algorithm will not adjust the heating setpoint by more than 4°F in any period.
   2. BMS shall determine the AHU supply air temperature setpoint based on the number of heating requests and cooling requests the AHU is receiving.
      a. If there are more cooling requests than heating requests coming into the AHU, or if there is the same number of heating requests as cooling requests, the AHU controller will use the cooling setpoint.
      b. If there are more heating requests than cooling requests coming into the AHU, the AHU controller will use the heating setpoint.
      c. When the BMS switches from the heating setpoint to the cooling setpoint, the setpoint control algorithm will ramp from the heating setpoint to the cooling setpoint at a rate of 1°F/minute.
      d. When the BMS switches from the cooling setpoint to the heating setpoint, the setpoint control algorithm will ramp from the cooling setpoint to the heating setpoint at a rate of 1°F/1.5 minute.
   3. The user will be able to override the supply air temperature setpoint.

F. Heating Control
   1. If the outside air temperature is less than 65°F with a 2°F hysteresis and the outside air temperature is valid, BMS will allow heating based on outside air conditions.
   2. If the outside air temperature reading is not valid, BMS will still allow heating.
   3. Upon a call for heating, dampers at energy recovery units shall be modulated to increase flow rate through the energy recovery section and reduce flow rate at the energy recovery's bypass. Energy recovery modules shall be the first stage of heating.

G. Cooling Control
   1. If the outside air temperature is greater than 50°F with a 2°F hysteresis and the outside air temperature is valid, the AHU controller will enable cooling based on outside air conditions.
   2. If the outside air temperature reading is not valid, the AHU controller will still enable cooling.

3. Upon a call for cooling, BMS shall modulate the chilled water valve, to maintain temperature setpoints if heating been off for at least 5 minutes.

H. Economizer Control
1. BMS will allow economizer cycles to be activated based on outside air conditions if the return air temperature and enthalpy is greater than the outside air temperature and enthalpy with a hysteresis of 5°F, the outside air enthalpy is less than 22 Btu/lb with a hysteresis of 2 Btu/lb, the outside air temperature is less than 65°F with a hysteresis of 2°F, and the outside air readings are valid.
2. If the outside air readings are not valid, BMS will disable the economizer. The user will be able to enable the economizer if the outside air readings are not valid.
3. When economizer cycles are activated, energy recovery motors shall stop and energy recovery bypass dampers shall open.
4. An economizer PID will modulate the economizer/ventilation dampers and relief air/exhaust fans between minimum setpoint and 100% to maintain the zone temperature at 2°F below the zone temperature cooling setpoint if heating has been off for at least 5 minutes. The relief air fans and exhaust fans shall and activated.
   a. The user will be able to adjust all PID parameters (P, I, and D gains, loop bias, and loop interval).
   b. The user will be able to lock the economizer damper position.
   c. The controller will limit the signal change sent to the economizer to 1% every 2 sec. when increasing.
5. The controller will limit the signal change sent to the economizer to 1% every 2 sec. when increasing.
6. If the mixed air temperature drops below 45°F, the AHU controller will begin to close the economizer to protect the coil. The controller will continue to close the damper linearly until the temperature drops to 40°F, when the economizer/ventilation damper will be 100% closed.
7. If the AHU loses flow or the freezestat trips, the AHU controller will close the economizer dampers.
8. The AHU controller will generate an alarm if the mixed air temperature remains lower than 45°F for 5 minutes with a 5°F hysteresis. This alarm will not be enabled until the supply fan has been running for 30 minutes.
9. The AHU controller will generate an alarm if the mixed air temperature remains higher than 90°F for 5 minutes with a 5°F hysteresis. This alarm will not be enabled until the supply fan has been running for 30 minutes.

I. Air Flow Monitoring Stations
1. Outside Air: BMS shall monitor the outside air flow station(s) and modulate the outside air and relief air dampers to maintain minimum outside air flow setpoint.
2. Supply air and return air flow rates at fans shall monitored as shown on the drawings.

J. Outside Air – Demand Control Ventilation
1. BMS shall monitor carbon dioxide (CO2) sensors. If CO2 levels rise above setpoint, the controller shall modulate the outside air and relief air dampers open an alarm shall be activated at the central PC.
2. System shall have the capability of reducing the amount of outside air based upon CO2 levels.

3.9 ERV UNITS

A. Heating Mode: If the outside air temperature is less than the economizer changeover and the discharge air temperature is less than the discharge air temperature setpoint the following shall occur:
   1. The supply and exhaust fans shall operate as sequenced above.

B. Stage 1 Free Heat:
   1. The energy recovery wheel shall be enabled.
   2. The outside air (wheel) by pass damper and the exhaust air (wheel) bypass damper shall modulate so as to maintain the discharge air temperature setpoint.
   3. The outside air damper shall modulate to their minimum outside airflow CFM.
   4. The recirculation damper shall modulate to its corresponding position.
   5. The hot water control valve shall modulate closed.

C. Stage 2 Heating:
   1. The energy recovery wheel shall be enabled.
   2. The outside air (wheel) bypass damper shall close.
   3. The exhaust air (wheel) bypass damper shall close.
   4. The outside air damper shall modulate to their minimum outside airflow CFM.
   5. The recirculation damper shall modulate to its corresponding position.
   6. The hot water control valve shall modulate so as to maintain the discharge air temperature setpoint.

D. Heating - General
   1. Upon a call for heating with the outside air is between 65°F and 40°F, BMS shall modulate the hot water valve, to maintain temperature setpoints if cooling has been off for at least 5 minutes.
   2. Upon a call for heating with the outside air below 40°F outside air, the hot water valve to maintain temperature setpoint if cooling has been off for at least 5 minutes.
      a. The user will be able to lock the signal to the hot water valve.
   3. Energy Recovery Modules - Frost Control: When outside air temperature is below unit's individual specific setpoint, bypass damper at the outside air side of the energy recovery module shall modulate open. If unit does not have a damper at the outside air, relief air/exhaust air bypass damper at the energy recovery module shall modulate open. Dampers shall modulate to maintain discharge air temperature setpoint.

E. Energy Wheel Frost Protection Control
   1. During the cold winter months, frost formation on the energy recovery wheel is a possibility. Frost formation can restrict or reduce the air flow across the energy wheel. To prevent frost build up on the wheel, the Delta controller shall monitor the outside air temperature, if the entering outside air temperature is less than the "Frost Control Setpoint" the controller shall initiate "De-Frost Mode". When in the "De-Frost Mode" the following shall occur:
   2. The energy recovery wheel shall be enabled.
   3. The outside air (wheel) bypass damper shall modulate to ensure that the exhaust air temperature is at or above the frost control setpoint.
   4. The outside air dampers and the recirculation damper shall modulate so as to maintain the discharge air temperature setpoint.
   5. The exhaust air (wheel) bypass damper shall be closed.
   6. The hot water control valve shall modulate so as to maintain the discharge air temperature setpoint.

F. The temperature below which frost will begin to accumulate on heat exchanger surfaces is referred to as the frost threshold temperature. It is a function of outdoor temperature and indoor relative humidity. The following table lists typical frost threshold temperatures over a wide range of indoor air temperatures and relative humidity. Frost control is not required until outdoor air temperatures are below the threshold.

FROST THRESHOLD TEMPERATURE (°F)				
INDOOR AIR RH%	INDOOR AIR DRY BULB TEMPERATURE (°F)			
	70°F	72°F	75°F	80°F
20	-14	-13	-11	-8
30	-3	-2	-1	3
40	5	7	9	11
50	12	13	15	18
60	18	19	21	26

G. Cooling Control
1. If the outside air temperature is greater than 50°F with a 2°F hysteresis and the outside air temperature is valid, the AHU controller will enable cooling based on outside air conditions.
2. If the outside air temperature reading is not valid, the AHU controller will still enable cooling.
3. Upon a call for cooling, BMS shall modulate the chilled water valve, to maintain temperature setpoints if heating been off for at least 5 minutes.

H. Cooling Mode with Energy Recovery
1. If the outside air temperature is greater than the economizer changeover setpoint and the outside air temperature is greater than the return air temperature the controller shall control the AHU as follows:
2. The supply and exhaust fans shall operate as sequenced above.
3. The energy recovery wheel shall be enabled.
4. The outside air (wheel) bypass damper shall close.
5. The exhaust air (wheel) bypass damper shall close.
6. The outside air damper shall open to their minimum outside airflow CFM.
7. The recirculation damper shall modulate to its corresponding position.
8. The chilled water valve shall modulate so as to maintain the required supply air temperature setpoint.

3.10 VAV BOXES (TYPICAL SOP UNLESS NOTED OTHERWISE)

A. Occupied Mode
1. When zone temperature rises above its cooling setpoint and cool air is available from the AHU, a cooling PID algorithm will modulate the control damper between the minimum occupied airflow and the maximum design cooling airflow until the zone is satisfied.
2. When the zone temperature is between the cooling setpoint and the heating setpoint, the zone controller will maintain the minimum occupied airflow, providing no less than the minimum required zone ventilation.
3. When zone temperature falls below its heating setpoint, a heating PID algorithm will modulate open the heating valve to maintain the zone temperature at its heating

setpoint. Additionally, if warm air is available from the AHU, the heating PID algorithm can modulate the control damper between the greater of the minimum occupied airflow or the minimum heating airflow and the maximum design heating airflow until the zone is satisfied.

4. Where more than one space temperature sensor serves a VAV box, the temperatures shall be averaged with absolute minimum –maximum setpoint programmed to override the average temperature.

B. Night Setback / Unoccupied Mode: When the zone is unoccupied, the zone controller will raise the cooling setpoint to 85°F, drop the heating setpoint to 65°F, and drop the minimum required airflow to 0 CFM. Space temperature sensors shall have an override button to change the VAV box from unoccupied to occupied mode for 3 hours.

C. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics.

D. Hot Water Coils: See sequences below.

E. Alarms

1. An alarm will be generated if the space temperature remains 4°F higher than its cooling setpoint or 4°F lower than its heating setpoint for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
2. Temperature sensor at the discharge of the VAV box shall be monitored.
3. An alarm shall be generated if the supply air temperature is below 50°F or above 120°F.

3.11 VAV BOXES – OCCUPANCY SENSOR

A. Space Occupied Mode: BMS shall monitor space occupancy sensor. If sensor indicates space is occupied, respective Supply Air VAV boxes shall move to the maximum airflow position.

B. Space Unoccupied Mode: BMS shall monitor space occupancy sensor. If sensor indicates space is unoccupied after a period of 10 minutes (adjustable), respective Supply Air and Exhaust Air VAV boxes shall move to the minimum airflow position.

C. BMS shall monitor airflows at each VAV box and shall adjust output signal to maintain correct airflow setting.

D. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics.

3.12 VAV BOXES – ROOMS WITH CO2 SENSORS

A. BMS shall monitor CO2 space sensors.

B. If CO2 levels rise above setpoint, BMS shall modulate the respective Supply Air and Exhaust Air VAV boxes open incrementally.

C. If CO2 levels fall below setpoint, BMS shall modulate the respective Supply Air and Exhaust Air VAV boxes closed incrementally.

D. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics.

3.13 FAN SEQUENCES OF OPERATION

A. All Fans: BMS shall monitor the operation or failure (fan status) through a current sensing relay switch. For fans with variable frequency drives (VFD), BMS shall monitor fan status through an alarm output contact at the VFD. If fan has been signaled to start and feedback from the relay or VFD does not indicate the fan has started after 30 seconds, fan shall be shut down and an alarm shall be activated at the central PC. If damper end switches do not indicate respective dampers are open, fan shall be shut down and an alarm shall be activated at the central PC. Conversely, if status is detected while the fan is turned off or a damper is indicated open, a separate "Hand" alarm shall be generated.

B. General exhaust shall operate per a time of day schedule and be interlocked to start when respective RTUs is operating.

C. Temperature Controls: Upon a rise in space temperature above sensor setpoint, associated motorized damper(s) shall open and respective fan shall start.

D. Time of Day: Associated motorized dampers shall open and respective fan shall start only during scheduled occupied modes.

E. Fans Controlled by Toggle Switches and Twist Type Timer Switches. Associated motorized dampers shall open and respective fan(s) shall start only when switch is in the “on” position. Operation shall also be subject to a Time of Day schedule.

F. Fans Served by a Differential Pressure Transmitters: If differential pressure is below setpoint, an alarm shall be activated at the central PC.

G. KEF-1:
1. Fan shall start when switch is in the “on” position. Operation shall be subject to a Time of Day schedule.
2. Fan shall automatically start if the temperature at the hood sensor is above setpoint. This operation shall not be subject to a time of day schedule.
3. If an alarm signal is received from the Kitchen fire suppression panel or Kitchen refrigerant monitoring panel, KEF-1 shall start. This operation shall not be subject to a time of day schedule
4. If KEF-1 is signaled to be on, AHU-1 shall start and outside air damper shall be at maximum open position as listed at the unit’s equipment schedule.
5. BMS shall monitor kitchen space temperature (monitor only).

H. DISHWASHER EXHAUST FAN (DEF-1)
1. The BMS shall monitor the dishwasher status and shall operate the dishwasher exhaust fan during dishwasher operation and for 30 minutes following dishwasher operation.
2. The BMS shall display the following information on a graphic:
   a. Exhaust fan status.

3.14 TERMINAL HEATING UNITS

A. Cabinet Unit Heater/Unit Heater: Upon a drop in space temperature below sensor setpoint, respective heating valve shall open and fan shall be energized subject to aquastat sensing hot water at the return branch piping. Temp sensors shall be analog input signals to BMS. Control wiring shall be low voltage, not line voltage. Fan shall not start until aquastat senses hot water.

B. Fin Tube Radiation/Panel Radiator: Upon a drop in space temperature below sensor setpoint, respective heating valve shall open in order to maintain desired space temperature setpoint. Radiation control for areas served by VAV boxes shall be sequenced together with the respective VAV box valve in order to maintain desired space temperature setpoint.

3.15 SPLIT SYSTEM AIR CONDITIONING UNITS

A. The Split System Air Conditioning units will be provided with integral controllers and wireless zone sensors by the unit manufacturer. The Units shall be provided with network communication interfaces and shall be on the VRF system network. The ATC will provide all network and condensing unit interlock wiring.

B. The BMS shall display the following information on a single graphic for each zone:
1. Space Temperature
2. Space temperature setpoint
3. Indoor unit status (On/Off/Alarm)

C. If the above information is not available from the Split System Control Network via the BACnet Communication Interface, the ATC shall be responsible for providing an additional controller in each zone and provide monitoring and alarm of space temperature and unit status at the OWS. The ATC shall be responsible for coordinating communication capabilities with the Split System Air Conditioning Unit Supplier.

3.16 DUCT MOUNTED FIRE/ SMOKE DAMPERS

A. Sequences of Operation listed below shall apply to all other smoke dampers and fire-smoke dampers.

B. BMS shall monitor status of the air handling unit (AHU / DOAS) served by duct mounted smoke damper.

C. When a unit is signaled to stop, BMS shall close all smoke dampers served by this unit. When a unit is signaled to start, BMS shall open respective smoke dampers.

D. At each smoke damper, BMS shall monitor end switch indicating damper open/close status. If a unit has been signaled to start and feedback from respective end switches does not indicate respective dampers are open after 30 seconds, an alarm shall be activated at the central PC. Conversely, after 30 seconds, if feedback indicates a damper is open when a unit is signaled to stop, an alarm shall be activated at the central PC.

E. Operation of each smoke damper shall also be controlled by fire alarm system. Refer to Drawing E402 and Specification Section 28 3100

3.17 GENERAL DEVICES

A. Variable Frequency Drives: BMS shall control start/stop of each VFD and shall monitor a general alarm contact at the VFD. If the VFD is in alarm mode, an alarm shall be activated at the central PC. BMS shall control speed of each VFD and monitor speed feedback.

B. Alarm Contacts: BMS shall monitor alarm contacts as shown on the drawings. If a device is in alarm mode, an alarm shall be activated at the central PC.

C. Fire Alarm: If fire alarm system is in alarm mode, BMS shall disengage controls associated with all fan system (in addition to hard wire shutdowns). When signal is received from the fire alarm system that all alarms are “cleared”; BMS shall restart all fan system incrementally.

D. Carbon Monoxide: BMS shall monitor and display alarms. If levels rise above setpoint, respective exhaust fan(s) shall start and heating and ventilating units shall start and provide 100% outside air. At the boiler room, boilers and water heater shall be shut down.

E. Leak Detector: If a detector is in alarm mode, the BMS shall shut down the respect fan, AC unit, etc and an alarm shall be activated at the central PC.

F. Emergency Generator: BMS shall monitor operations of the generator. If generator is on (not test mode), BMS shall shut down operation of chiller plant, AHU’s, DOAS units, VRV units and CU’s serving VRV units. After normal power is restored (signal form generator), BMS shall stage equipment back on incrementally.

3.18 DOMESTIC HOT WATER AND PUMPS

A. Domestic Hot Water Recirculating Pump: Pump shall be controlled per a time of day schedule and shall be activated during occupied modes.

3.19 OUTDOOR AIR CONDITIONS MONITORING

A. Functional Control
   1. The controller will read the outside air temperature and humidity and calculate the outside air enthalpy, and will make these values available to the system.
   2. If the outside air temperature sensor indicates a reading lower than -25°F with a hysteresis of 10 or higher than 225°F with a hysteresis of 10 the controller will make the alternate outside air temperature sensor available to the system. If the sensor still indicates these readings after 5 minutes, the controller will generate a sensor failure alarm.

B. Temperature History
   1. Once the controller has established communication with the system after any interruption in communication, it will record a temperature history for the system.
      a. At 12:05 am every night, the controller will reset the high and low daily temperature peak recorders for the next day. The reset signal will last no longer than 5 seconds.
      b. When the high and low daily temperature peak recorders are reset for the first day of each month, the high and low month-to-date peak recorders will also be reset.
      c. When the high and low month-to-date peak recorders are reset for January, the high and low year-to-date peak recorders will also be reset.

3.20 ALARM NOTIFICATION

A. Events and alarms shall be indicated on the appropriate equipment graphics page viewable and with automatic display updates available at the central server level. The graphic display will indicate an alarm condition by showing the appropriate object in red on the graphic display.

B. Alarms and events shall be displayed on the Event Log Page viewable and with automatic display updates available at the central server level. Date and time of occurrence shall be recorded.

C. Alarms and events shall be transferred out of the automation system to other network services for remote notification to devices such as: Printers on the customer's network, e-mail systems, voice mail systems, paging systems, local alarms, or other reporting actions, depending on user configuration. Contractor shall coordinate with the Owner with programming and wiring remote alarms and trouble shooting them for accuracy.

3.21 TRENDING

A. All I/O points shall be linked to a trend log.
1. BMS shall record a trend sample every 10 minutes on each of the trend objects.
2. The controller will save the most recent 144 samples of each trended point in the control module for viewing or printing.
3. The user will be able to enable or disable trending of any of the points listed. Points marked with an asterisk will automatically be trended in the default configuration.
4. For the first year of operation, the system will trend and record all data at 10 minute increments which can then be backed up on CD's.
5. A dedicated trend log page shall be setup to permanently monitor and record all indoor and outdoor conditions as follows (per State of CT HPB requirements): Temperature, humidity, relative humidity, dewpoint, CO2.

3.22 COMMISSIONING

A. Engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 23 08 00.

B. Verify that equipment is installed and commissioned as per requirements of Section 23 08 000 and manufacturer's written instructions.

C. Complete installation and startup checks and functional tests according to Section 23 08 00 and manufacturer's written instructions.

D. Operational Test: After electrical and control systems have been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the start up procedure.

E. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Heating water piping, above ground.
2. Chilled water piping, buried.
3. Chilled water piping, above grade.
4. Coil condensate drain piping
5. Equipment drains and over flows.
6. Unions and flanges.

B. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product and execution requirements for expansion compensation devices use in heating and cooling piping systems.
4. Section 23 05 23 - General-Duty Valves for HVAC Piping: Product requirements for valves for placement by this section.
5. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, and firestopping for placement by this section.
6. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
7. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
8. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
9. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties used in heating and cooling piping systems.
10. Section 23 21 23 - Hydronic Pumps: Product and execution requirements for pumps used in heating and cooling piping systems.
11. Section 23 25 00 - HVAC Water Treatment: Product and execution requirements for cleaning and chemical treatment of heating and cooling piping systems.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
3. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
4. ASME B31.9 - Building Services Piping.

B. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM A536 - Standard Specification for Ductile Iron Castings.
4. ASTM B32 - Standard Specification for Solder Metal.
5. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
6. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
7. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
8. ASTM F441/F441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
9. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
10. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
11. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:
1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and Grooved coupling couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

C. Provide pipe hangers and supports in accordance with ASME B31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.

D. Flexible Connectors or Grooved coupling Flexible Couplings: Use at or near motor driven equipment where piping configuration does not absorb vibration. Three (3) flexible couplings may be used in lieu of each flexible connector for vibration attenuation. Couplings shall be placed in close proximity to the vibrating source in accordance with published guidelines.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate schematic layout of piping system, including equipment, critical dimensions, and sizes.
   1. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable Grooved coupling style or series number.

C. Product Data:
   1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.

D. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Test Reports: Indicate results of piping system pressure test.

F. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

H. Welders' Certificate: Include welders' certification of compliance with ASME Section IX and AWS D1.1.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves, equipment and accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

C. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experienced.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer’s standard, no less than one year from date of Owner’s acceptance.

C. Furnish five year manufacturer warranty for valves excluding packing.

PART 2 PRODUCTS

2.1 HEATING WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, black.
   1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
   2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, black, cut grooved ends.
   1. Fittings: ASTM A536 ductile iron or ASTM A53 forged steel or fabricated from carbon steel pipe, grooved ends designed to accept Grooved coupling standard or AGS "W" series couplings.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: ASTM A536 ductile iron, enamel coated, compatible with steel piping sizes, rigid or flexible type.
         1) Rigid Type: 2 inch through 12 inch: "Installation ready" rigid coupling with angle pattern bolt pads designed for direct 'stab' installation onto grooved end pipe without prior disassembly of the coupling, no torque requirement and Grade "EHP" EPDM gasket.
         2) Flexible Type: 2 inch through 24" inch: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. Three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration.
      b. Grade "EHP" EPDM Gasket: Elastomer composition for operating temperature range from -30 degrees F to 250degrees F
      c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type L, drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

D. Copper Tubing: ASTM B88, Type L, drawn, rolled grooved ends.
   1. Fittings: ASME B16.18 cast copper alloy, or ASME B16.22 wrought copper and bronze or ASTM B584 bronze sand castings, with copper tube dimensioned grooved ends. Flaring of tube and fitting ends to IPS dimensions is not permitted.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476. "Installation ready" stab-on design for direct installation onto roll grooved copper tube without prior field disassembly.
      a. Housing Clamps: Installation-ready ASTM A536 ductile iron, cast with offsetting, angle-pattern bolt pads, copper-color enamel coated, compatible with copper tubing sizes, to engage and lock with no torque requirement. .
      b. Gasket: Elastomer Grade "EHP" EPDM composition for operating temperature range from -30 degrees F to 250 degrees F.
      c. Accessories: Steel bolts, nuts, and washers.

2.2 CHILLED WATER PIPING, BURIED

A. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black with AWWA C105 polyethylene jacket, or double layer, half-lapped 10 mil polyethylene tape.
   1. Fittings: ASTM A234/A234M forged steel welding type with double layer, half-lapped 10 mil polyethylene tape.
   2. Joints: Welded.

B. Copper Tubing: ASTM B88, Type K annealed.
   1. Fittings: ASME B16.22, wrought copper.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.3 CHILLED WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, black.
   1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
   2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M Schedule 40, black, cut grooved ends.
   1. Fittings: ASTM A536 ductile iron, or ASTM A53 forged steel or fabricated from carbon steel pipe, grooved ends designed to accept Grooved coupling standard or AGS "W" series couplings.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: ASTM A536 ductile iron, enamel coated, compatible with steel piping sizes, rigid or flexible type.
         1) Rigid Type: 2 inch through 12 inch: "Installation ready" rigid coupling with angle pattern bolt pads designed for direct 'stab' installation onto grooved end pipe without prior disassembly of the coupling, no torque requirement and Grade "EHP" EPDM gasket.
         2) Flexible Type: 2 inch through 24" inch: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. Three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration.
      b. Grade "EHP" EPDM Gasket: Elastomer composition for operating temperature range from-30 degrees F to 250degrees F
      c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type L, drawn.
   1. Fittings:
      a. ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

D. Copper Tubing: ASTM B88, Type L, drawn, rolled grooved ends.
   1. Fittings: ASME B16.18 cast copper alloy, or ASME B16.22 wrought copper and bronze, or ASTM B584 bronze sand castings, with copper tube dimensioned grooved ends. Flaring of tube and fitting ends to IPS dimensions is not permitted.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476. "Installation ready" stab-on design for direct installation onto roll grooved copper tube without prior field disassembly.
      a. Housing Clamps: Installation-ready ASTM A536 ductile iron cast with offsetting, angle-pattern bolt pads, copper-color enamel coated, compatible with copper tubing sizes, to engage and lock with no torque requirement.
      b. Gasket: Grade "EHP" EPDM Elastomer composition for operating temperature range from -30 degrees F to 250 degrees F
      c. Accessories: Steel bolts, nuts, and washers.

2.4 COIL CONDENSATE DRAIN PIPING

A. Copper Tubing: ASTM B88, Type L, drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.5 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized.
1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.
2. Joints: Threaded for pipe 2 inch and smaller; flanged for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized, cut grooved ends.
1. Fittings: ASTM A536 ductile iron, or ASTM A53/A53M forged carbon steel or fabricated from carbons steel pipe grooved ends designed to accept Grooved coupling or AGS “W” series couplings.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.
a. Housing Clamps: ASTM A536 ductile iron, enamel coated, compatible with steel piping sizes, rigid or flexible type.
1) Rigid Type: 2 inch through 12 inch: “Installation ready” rigid coupling with angle pattern bolt pads designed for direct ‘stab’ installation onto grooved end pipe without prior disassembly of the coupling, no torque requirement and Grade “EHP” EPDM gasket.
2) Flexible Type: 2 inch through 12 inch: Use in locations where vibration attenuation and stress relief are required.
b. Grade “EHP” EPDM Gasket: Elastomer composition for operating temperature range from-30 degrees F to 250 degrees F.
c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type L, drawn.
1. Fittings:
a. ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F. For 2” and larger, Victaulic CTS System may be used

2.6 FLUE AND COMBUSTION AIR PIPING

A. CPVC Pipe: ASTM F441/F441M, Schedule 40, chlorinated polyvinyl chloride (CPVC) material.
1. Fittings: ASTM F438, CPVC, Schedule 40, socket type.
2. Joints: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement. Prime joints with a contrasting color.

2.7 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with soldered.
3. Dielectric Connections:
a. Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
b. Waterway fitting with zinc electroplated steel or ductile iron body, male thread, grooved, or plain end, water impervious isolation barrier.
4. CPVC Piping: CPVC.

B. Flanges for Pipe 2-1/2 inches and Larger:
1. Ferrous Piping:
a. Class 150, forged steel, slip-on flanges.

b. Grooved joint flange adapter, flat face, for direct connection to ANSI Class 125 and 150 flanges. For direct connection to ANSI Class 300 flanges

2. Copper Piping:
   a. Class 150, slip-on bronze flanges.
   b. Grooved joint flange adapter, flat face, for direct connection to ANSI Class 125 and 150 flanges.
3. CPVC Piping: CPVC flanges.
4. Gaskets: 1/16 inch thick preformed neoprene gaskets.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install pipe hangers and supports in accordance with Section 23 05 29.

3.4 INSTALLATION - BURIED PIPING SYSTEMS

A. Remove scale and dirt on inside of piping before assembly.

B. Install chilled water piping in accordance with ASME B31.9.

C. Install pipe to elevation as indicated on Drawings.

D. Route pipe in straight line.

E. Install pipe to allow for expansion and contraction without stressing pipe or joints.

F. Install plastic ribbon tape continuous over top of pipe.

3.5 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Install heating water and chilled water piping in accordance with ASME B31.9.

B. Route piping parallel to building structure and maintain gradient.

C. Install piping to conserve building space, and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.

F. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 07 84 00.

G. Install pipe identification in accordance with Section 23 05 53.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

I. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13.

J. Slope hydronic piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

L. Install valves with stems upright or horizontal, not inverted.

M. Insulate piping and equipment; refer to Section 23 07 00.

N. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. A factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
   1. Install the AGS piping system in accordance with the latest installation instructions. Use grooving tools with AGS roll sets to groove the pipe. Follow guidelines for tool selection and operation. Coupling installation shall be complete when visual metal-to-metal contact is reached. AGS products shall not be installed with standard grooved end pipe or components. Installing AGS products in combination with standard grooved end products could result in joint separation and/or leakage.

3.6 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test heating water piping system and chilled water piping system in accordance with ASME B31.9.

END OF SECTION

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pressure gages.
2. Pressure gage taps.
3. Thermometers.
4. Thermometer supports.
5. Diaphragm-type expansion tanks.
6. Air vents.
7. Air separators.
8. Strainers.
9. Pump suction fittings.
10. Combination pump discharge valves.
11. Flow controls.
12. Relief valves.
13. Glycol solution.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 21 13 - Hydronic Piping: Execution requirements for piping connections to products specified by this section.
3. Section 23 21 23 - Hydronic Pumps: Execution requirements for piping connections to products specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. ASTM International:
1. ASTM E1 - Standard Specification for ASTM Thermometers.
2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit for manufactured products and assemblies used in this Project.
1. Manufacturer’s data [and list] indicating use, operating range, total range, accuracy, and location for manufactured components.
2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of actual locations of components and instrumentation and flow controls.

C. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.9 FIELD MEASUREMENTS

A. Verify field measurements before fabrication.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer's standard, no less than one year from date of Owner's acceptance.

PART 2 PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:
1. Trerice
2. Ernst
3. Davis
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Gage: ASME B40.1, with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
1. Case: Fiberglass reinforced polypropylene.
2. Bourdon Tube: Brass.
3. Dial Size: 4 inch diameter.
4. Mid-Scale Accuracy: two percent.
5. Scale: Psi.

2.2 PRESSURE GAGE TAPS

A. Manufacturers:
1. Trerice
2. Ernst
3. Davis
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Ball Valve: Brass, 1/4 inch NPT for 250 psi.

C. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections.

D. Siphon: Brass, 1/4 inch NPT angle or straight pattern.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:
1. Trerice
2. Ernst
3. Davis
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
1. Size: 9 inch scale.
2. Window: Clear glass.
3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.

4. Accuracy: ASTM E77 2 percent.
5. Calibration: Degrees F.

2.4 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions, and with cap and chain.

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.5 DIAPHRAGM-TYPE EXPANSION TANKS

A. Manufacturers:
1. B+G
2. Amtrol
3. Taco
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank [, and steel support stand].

C. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 12 psig.

D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow prevention device, test cocks, strainer, vacuum breaker, and by-pass valves.

2.6 AIR VENTS

A. Manufacturers:
1. B+G
2. Amtrol
3. Taco
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

C. Float Type:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.7 AIR SEPARATORS

A. Manufacturers:
1. B+G
2. Taco
3. Spirotherm
4. Substitutions: Section 01 60 00 - Product Requirements.

B. In-line Air Separators: Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger; tested and stamped in accordance with ASME Section VIII; for 125 psig operating pressure.

2.8 STRAINERS

A. Manufacturers:
1. Sarco
2. Armstrong
3. Yarway
4. Victaulic
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Size 2 inch and Smaller:
1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:
1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
2. Grooved ductile iron body for 300 psi working pressure, Y-pattern with .062 inch minimum stainless steel perforated screen
3. Grooved ductile iron body for up to 750 psi working pressure, T-pattern with .063 inch minimum stainless steel perforated screen

D. Size 5 inch and Larger:
1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.
2. Grooved ductile iron body for 300 psi working pressure, Y-pattern with .125 inch minimum stainless steel perforated screen. Provide 14 inch and larger with AGS grooved ends
3. Grooved ductile iron body for up to 750 psi working pressure, T-pattern with .063 inch minimum stainless steel perforated screen. Provide 14 inch and larger with AGS grooved ends

2.9 PUMP SUCTION FITTINGS

A. Manufacturers:
1. B+G
2. Taco
3. Armstrong
4. Victaulic
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Fitting: Angle pattern, cast-iron body. Threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger. Rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

C. Fitting: Angle pattern, flanged pump inlet with grooved outlet system connections, 300-psig pressure rating, ductile-iron body, 304 stainless steel frame and sheet diffuser with 5/32”

diameter holes 3” through 12” inlet sizes, and 3/16” diameter holes 14” through 24” inlet sizes. Removable 20 mesh 304 stainless steel start-up prefilter, outlets for pressure/temperature drain connections, and base support boss. Provide 14 inch and larger with AGS grooved end

D. Accessories: Adjustable foot support, blow-down tapping in bottom, gage tapping in side.

2.10 COMBINATION PUMP DISCHARGE VALVES

A. Manufacturers:
1. B+G
2. Taco
3. Armstrong
4. Victaulic
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

C. Tri-Service Valve Assembly-Grooved End: Straight pattern, 300-psig pressure rating, combination shut-off, throttling, and non-slam check service in one unit. Victaulic MasterSeal™ butterfly valve assembled with Venturi Check valve with flow measurement capabilities and Victaulic couplings (style to be determined by system requirements) for 2” through 12”. Straight pattern, 230-psig pressure rating combination shut-off, throttling, and non-slam check service in one unit. Victaulic AGS butterfly valve assembled with AGS dual-disc check valve and Victaulic couplings for 14”-24”.

2.11 FLOW CONTROLS – MANUAL AND AUTOMATIC TYPE

A. GENERAL
1. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with combination blow-down and back-flush drain.
2. Calibration: Control within 10 percent of design flow over entire operating pressure with a maximum operating temperature of at least 232 deg F.

B. Automatic Control Valves shall include:
1. Control Mechanism: Either piston and spring or diaphragm and orifice plates are acceptable types. For piston and spring types: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring. For diaphragm and orifice plate types: elastomeric polymer diaphragm with polyphenylsulfone orifice seat.
2. Accessories: In-line strainer on inlet and ball valve on outlet.
3. Manufacturer shall be able to provide certified independent laboratory tests verifying accuracy of performance. (Consult the factory for details).
4. All flow control valve cartridges shall be warranted by the manufacturer for five years from date of sale.
5. The body design shall allow inspection or removal of 20 mesh stainless steel strainer without disturbing piping connections.
6. Ball Valve shall be made of brass. Maximum pressure rating of 400 PSI. Ball Valve shall include a union end which will accept various end pieces.
7. The body design shall allow inspection or repair of handle operated stem without disturbing piping connections. The repairable stem shall include two Teflon seals and one EPDM O-ring for protection against chemicals and modulating temperature.

8. A pressure/temperature test valve, manual air vent and drain valve shall be included.
9. Dual pressure or pressure/temperature test valves for verifying accuracy of flow performance shall be provided for all valve sizes.
10. Valve shall have a body tag to indicate model number and a hanging tag showing Cv and flow/delta P reading required for specific flow rate.
11. Manufacturers of automatic valves:
    a. Nexus
    b. Griswold
    c. Flow Design
    d. Hays Fluid Controls
    e. Victaulic
12. Substitutions: Not Permitted.

C. Manual Control Valves shall include:
1. Valves shall have ASTM brass alloy housing, rated at no less than 400PSI/250°F. Valves shall include an isolation ball valve with equal percentage port and memory stop, a venturi measurement piece, dual pressure/temperature test valves for flow reading, and a union end which will accept various end pieces.
2. The body design shall allow inspection or repair of handle operated stem without disturbing piping connections. The repairable stem shall include two Teflon seals and one EPDM O-ring for protection against chemicals and modulating temperature.
3. The valve shall come fully assembled and be permanently marked to show direction of flow.
4. Valve shall have a body tag to indicate model number and a hanging tag showing Cv and flow/delta P reading required for specific flow rate.
5. Manufacturers of manual valves:
    a. Nexus
    b. Griswold
    c. Flow Design Model
    d. Watts.
    e. Substitutions: Section 01 60 00 - Product Requirements.

D. Manual Y-Pattern Combination Balancing & Shutoff Valves:
1. 2” and Smaller Sizes: 300 psi, threaded or soldered ends; non-ferrous Ametal® brass copper alloy body, EPDM o-ring seals. 4-turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting. Victaulic / TA Hydronics Series 787, 78K STAD or 786 STAS.
2. 2-1/2” and Larger Sizes: 250 psi Flanged or 350 psi Grooved ends, ASTM A536 ductile iron body, all other metal parts of Ametal® brass copper alloy, EPDM O-ring seals. 8, 12 or 16 turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting. Victaulic / TA Hydronics Series 789 STAG or 788 STAF
3. Coil hook-up assemblies may be used to reduce installation time and space requirements. Victaulic TA Series 799 or 79V Koil Kit coil pack assembly. Coil pack can include; Victaulic Series 78U union port fitting, Series 78Y strainer/ball valve or Series 78T union/ball valve combination, and two flexible hoses
4. Manufacturers of manual Y-pattern valves:
    a. Victaulic/Tour & Andersson
    b. Nibco
    c. Armstrong

2.12 RELIEF VALVES

A. Manufacturers:
1. Watts
2. Tyco
3. Parker Hannifin
4. B+G
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

2.13 GLYCOL SOLUTION

A. Manufacturers:
1. DowFrost - Model - HD.
2. Houghton Chemical – Model – Safe-T-Therm.
3. Interstate Chemicals – Model – InterCool P300.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Inhibited propylene glycol and water solution mixed 30 percent glycol - 70 percent water.

PART 3 EXECUTION

3.1 INSTALLATION - THERMOMETERS AND GAGES

A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.

B. Install gage taps in piping

C. Install pressure gages with pulsation dampers. Provide ball valve to isolate each gage. Extend nipples to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.

E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, pipe mounted thermometers are not required.

F. Coil and conceal excess capillary on remote element instruments.

G. Provide instruments with scale ranges selected according to service with largest appropriate scale.

H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

A. Locate test plugs adjacent to thermometers and thermometer sockets, adjacent to pressure gages and pressure gage taps, adjacent to control device sockets and as indicated on Drawings.

B. Install manual air vents at system high points.

C. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.

D. Provide air separator on suction side of system circulation pump and connect to expansion tank.

E. Provide drain and hose connection with valve on strainer blow down connection.

F. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.

G. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.

H. Support pump fittings with floor mounted pipe and flange supports.

I. Provide relief valves on pressure tanks, low-pressure side of expansion tanks.

J. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

K. Pipe relief valve outlet to nearest floor drain.

L. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirement]: Field inspecting, testing, adjusting, and balancing.

B. Test for strength of glycol and water solution and resultant pH value and submit written test results.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Clean and flush glycol system before adding glycol solution.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting installed construction.

B. Do not install hydronic pressure gauges until after systems are pressure tested.

3.6 SCHEDULES

A. Pressure Gages.
   1. Pumps.
   2. Expansion tanks.

B. Pressure Gage Tapping Location:
   1. Control valves 3/4 inch & larger - inlets and outlets.
   2. Major coils - inlets and outlets.
   3. Chiller - inlets and outlets.
   4. Boiler - inlets and outlets.

C. Stem Type Thermometers:
   1. Headers to central equipment.
   2. Coil banks - inlets and outlets.
   3. Boilers - inlets and outlets.
   4. Chiller - inlets and outlets.

D. Thermometer Socket Location:
   1. Control valves 1 inch & larger - inlets and outlets.
   2. Reheat coils - inlets and outlets.
   3. Cabinet heaters - inlets and outlets.
   4. Unit heaters - inlets and outlets.

END OF SECTION

SECTION 232123 - HYDRONIC PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Base mounted pumps.

B. Related Sections:
   1. Section 23 04 00 – General Conditions for Mechanical Trades
   2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
   3. Section 23 05 23 - General-Duty Valves for HVAC Piping: Product requirements for valves used in hydronic piping systems.
   4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibrations isolators installed with pumps.
   5. Section 23 21 13 - Hydronic Piping: Execution requirements for connection to pumps specified by this section.
   6. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties installed in hydronic systems adjacent to pumps.
   7. Division 26: Execution requirements for electrical connections to pumps specified by this section.

1.2 PERFORMANCE REQUIREMENTS

A. Provide pumps to operate at system fluid temperatures [indicated on Drawings] without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.

C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.

C. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for pumps.

1.10 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish one set of mechanical seals for pumps.

PART 2 PRODUCTS

2.1 BASE MOUNTED PUMPS

A. Manufacturers:
1. B+G
2. Taco
3. Armstrong
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Type: Horizontal shaft, single stage, direct connected, radial or horizontal split casing, for 125 psig maximum working pressure.

C. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

D. Impeller: Bronze, fully enclosed, keyed to shaft.

E. Bearings: Permanently lubricated roller or ball bearings.

F. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

G. Seal: Carbon rotating against stationary ceramic seat, 212 degrees F maximum continuous operating temperature.

H. Drive: Flexible coupling with coupling guard.

I. Baseplate: Cast iron or fabricated steel with integral drain rim.

J. Performance:
1. Refer to schedules on the construction drawings.

K. Electrical Characteristics and Components:
1. Refer to schedules on construction drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge line sizes 4 inches and over.

C. Install pumps on vibration isolators. Refer to Section 23 05 48.

D. Install flexible connectors at or near pumps where piping configuration does not absorb vibration. On Victaulic grooved installations, install three (3) Flexible couplings in lieu of each flexible connector and place in close proximity to the vibrating source. Refer to Section 23 21 16.

E. Provide line sized shut-off valve and strainer on pump suction, and line sized combination pump discharge valve on pump discharge. On Victaulic grooved installations, provide line sized combination Tri-Service Assembly or AGS Tri-Service Assembly with grooved ends. Refer to Section 23 05 23 and Section 23 21 16.

F. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and larger.

G. Provide air cock and drain connection on horizontal pump casings.

H. Provide drains for bases and seals.

I. Check, align, and certify alignment of base mounted pumps prior to start-up.

J. Install base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00.

K. Lubricate pumps before start-up.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect for alignment of base mounted pumps.

END OF SECTION

SECTION 232300 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Refrigerant piping.
2. Unions, flanges, and couplings.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, and firestopping for placement by this section.
3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
4. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
5. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.

1.2 REFERENCES

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

B. American Society of Mechanical Engineers:
1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B31.5 - Refrigeration Piping.

C. ASTM International:
1. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
2. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.

C. Provide pipe hangers and supports in accordance with ASME B31.5, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.

D. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.

C. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories.

D. Test Reports: Indicate results of refrigerant leak test.

E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.

C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer’s standard, no less than one year from date of Owner’s acceptance.

PART 2 PRODUCTS

2.1 REFRIGERANT PIPING

A. Copper Tubing: ASTM B280, drawn.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.2 UNIONS, FLANGES, AND COUPLINGS

A. 2 inches and Smaller:
   1. Copper Pipe: Bronze, soldered joints.

B. 2-1/2 inches and Larger:
   1. Copper Piping: Bronze.
   2. Gaskets: 1/16 inch thick preformed neoprene.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install pipe hangers and supports in accordance with Section 23 05 29.

3.4 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Route piping parallel to building structure and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.

E. Install pipe identification in accordance with Section 23 05 53.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13.

H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Flood refrigerant piping system with nitrogen when brazing.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

K. Insulate piping; refer to Section 23 07 00.

L. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

M. Fully charge completed system with refrigerant after testing.

N. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

O. Install refrigerant piping in accordance with ASME B31.5.

3.5 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test refrigeration system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig using electronic leak detector.]]

D. Repair leaks.

E. Retest until no leaks are detected.

END OF SECTION

SECTION 232500 - HVAC WATER TREATMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. System cleaner.

B. Related Sections:
   1. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.3 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience with water analysis laboratories and full time service personnel.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.4 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 SYSTEM CLEANER

A. Manufacturers:
   1. Biomin
   2. Culligan
   3. Aptech
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tri-Poly phosphate and sodium molybdate.

PART 3 EXECUTION

3.1 PREPARATION

A. Operate, fill, start and vent systems prior to cleaning. Use water meter to record capacity in each system. Place terminal control valves in open position during cleaning.

3.2 CLEANING

A. Concentration:
   1. As recommended by manufacturer.

B. Hot Water Heating Systems:
   1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
   2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
   3. Circulate for 6 hours at design temperatures, then drain.
   4. Refill with clean water and repeat until system cleaner is removed.

C. Chilled Water Systems:
   1. Circulate for 48 hours, then drain systems as quickly as possible.
   2. Refill with clean water, circulate for 24 hours, then drain.
   3. Refill with clean water and repeat until system cleaner is removed.

D. Use neutralizer agents on recommendation of system cleaner supplier and acceptance of Architect/Engineer.

E. Flush glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

F. Remove, clean, and replace strainer screens.

G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

END OF SECTION

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Duct Materials.
2. Insulated flexible ducts.
3. Single wall spiral flat oval ducts.
4. Transverse duct connection system.
5. Ductwork fabrication.
6. Kitchen hood exhaust ductwork fabrication.
7. Duct cleaning.
8. Ductwork leakage testing.

B. Related Sections:
1. Section 11 40 00 - Foodservice Equipment: Product requirements for kitchen range hoods for placement by this section.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
4. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.2 REFERENCES

A. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
4. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
5. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

C. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Air Duct Leakage Test Manual.
2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

D. Underwriters Laboratories Inc.:
1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 PERFORMANCE REQUIREMENTS

A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
   1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
   2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
   3. Fittings.
   4. Reinforcing details and spacing.
   5. Seam and joint construction details.
   6. Penetrations through fire rated and other walls.
   7. Terminal unit, coil, and humidifier installations.
   8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

C. Product Data: Submit data for duct materials and duct connectors.

D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

E. Manufacturer's Installation Instructions: Submit special procedures for glass fiber ducts.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

B. Construct ductwork to NFPA 90A and NFPA 96 standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.

C. Maintain temperatures during and after installation of duct sealant.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer’s standard, no

PART 2 PRODUCTS

2.1 DUCT MATERIALS

A. Manufacturers:
1. United McGill
2. Semco
3. ACME
4. Nufab
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90/A90M.

C. Fasteners: Rivets, bolts, or sheet metal screws.

D. Hanger Rod: ASTM A36/A36M; steel [, galvanized]; threaded both ends, threaded one end, or continuously threaded.

2.2 INSULATED FLEXIBLE DUCTS

A. Manufacturers:
1. Thermaflex Model M-KF
2. Technaflex
3. Tuttle + Bailey
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Two ply vinyl film supported by helical wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
   1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
   2. Maximum Velocity: 4000 fpm.
   3. Temperature Range: -10 degrees F to 160 degrees F.
   4. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.

2.3 SINGLE WALL SPIRAL ROUND DUCTS

A. Manufacturers:
   1. McGill AirFlow Corporation
   2. Semco Incorporated
   3. Tangent Air Corp
   4. Spiral Mfg. Co., Inc.
   5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: UL 181, Class 1, round spiral lockseam duct constructed of galvanized steel.

C. Construct duct with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	26
15 inches to 26 inches	24
28 inches to 36 inches	22
38 inches to 50 inches	20
52 inches to 84 inches	18

D. Construct fittings with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	24
15 inches to 26 inches	22
28 inches to 36 inches	20
38 inches to 50 inches	20
52 inches to 60 inches	18
62 inches to 84 inches	16

2.4 TRANSVERSE DUCT CONNECTION SYSTEM

A. Manufacturers:
   1. United McGill
   2. Semco
   3. ACME
   4. Nufab
   5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: SMACNA "E" rated, SMACNA "F" rated or SMACNA "J" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.5 DUCTWORK FABRICATION

A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards), and [as indicated on Drawings]. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. TDC connections on all ductwork where any dimension exceeds 12 inches. Slip and drive connection acceptable on duct sizes less than 12” x 12”.

D. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide [airfoil] turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

G. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

H. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems.
   1. Sealants, Mastics: Conform to UL 181A. Provide products bearing appropriate UL 181A markings.
   2. Do not provide sealing products not bearing UL approval markings.

2.6 KITCHEN HOOD EXHAUST DUCTWORK FABRICATION

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.

B. Exposed Kitchen Hood Exhaust Ducts: Construct of stainless steel ASTM A240/A240M OR ASTM 666, type 304 using continuous external welded joints.

C. Concealed Kitchen Hood Exhaust Ducts: Construct of 16 gage carbon steel or 18 gage stainless steel ASTM A240/A240M OR ASTM 666, type 304 using continuous external welded joints.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

C. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inch and smaller.

D. Install duct hangers and supports in accordance with Section 23 05 29.

E. Use double nuts and lock washers on threaded rod supports.

F. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

G. Install kitchen range hoods in accordance with NFPA 96. Refer to Section 11 40 00.

H. Install residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for clean out.

I. Kitchen hood exhaust ducts: Use stainless steel for ductwork exposed to view and stainless steel or carbon steel where ducts are concealed.

J. Exhaust Outlet Locations:
1. Minimum Distance from Property Lines: 3 feet.
2. Minimum Distance from Building Openings: 3 feet.
3. Minimum Distance from Outside Air Intakes: 10 feet.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

B. Connect air outlets and inlets to supply ducts with five foot maximum length of flexible duct. Do not use flexible duct to change direction.

3.4 CONCEALED GREASE DUCT TESTING

A. Prior to concealing, wrapping, or insulating grease ductwork, or placing grease duct in service, perform leakage test in accordance with ICC IMC, in presence of authority having jurisdiction.

B. Perform light test by pulling minimum 100 W light through duct and observing for light leaks at duct joints.

C. Test complete extent of duct installed, including joint at which duct connects to exhaust hood.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air flow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.

3.6 DUCTWORK LEAKAGE TESTING

A. The following ductwork systems shall be pressure/leakage tested:
1. All ductwork to be concealed in a sheetrock, concrete block or other permanent chase shall be pressure tested before ductwork is concealed.
2. All ductwork systems listed below that are constructed and installed for 3” w.c. or more (positive or negative).
3. For ductwork leakage testing: “Ductwork main” shall be defined as all ductwork serving more than one grille or diffuser.
4. All ductwork outside of the building insulation envelope shall be pressure tested.

B. Testing shall conform to the following:
1. Test in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Maximum Allowable Leakage shall be in accordance with Duct Pressure Class rating listed below and Leakage Class listed here-in.
2. For Ductwork Pressure Class 3” w.c: Leakage Class shall be 8.
3. For Ductwork Pressure Class 2” w.c or less: Leakage Class shall be 16.
4. Testing shall occur after ductwork has been cleaned, but before duct insulation is applied or ductwork is concealed.

C. Duct Leakage Test Report shall include:
1. Date of test.
2. Name of company and person conducting the test.
3. Name of company and person witnessing the test.
4. Description of ductwork tested. Provide drawings to indicate section of ductwork being tested. Labeling on the drawings shall correspond to labeling in the report.
5. Surface area (square feet) of section of ductwork being tested.
6. Duct design operating pressure (inches w.c.)
7. P = Duct design test static pressure (inches w.c.)
8. Duct capacity, air flow
9. CL= Specified Leakage Class.
10. F = Leakage factor (CFM / 100 sf of duct area)
11. Maximum allowable leakage (CFM)
12. Test apparatus
    a. Blower
    b. Orifice tube size
    c. Orifice size
    d. Calibrated

13. Test orifice differential pressure (inches w.c.)

3.7 SCHEDULES

A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Supply	Steel
Return and Relief	Steel
General Exhaust	Steel
Kitchen Hood Exhaust	Steel, Stainless Steel

B. Ductwork Pressure Class Schedule:

AIR SYSTEM	PRESSURE CLASS
Variable Air Volume Supply (downstream of VAV boxes)	1 inch wg regardless of velocity.
Variable Air Volume Supply (upstream of VAV boxes)	3 inch wg
Return and Relief	1 inch wg regardless of velocity.
General Exhaust	1 inch wg regardless of velocity.
Dishwasher Exhaust	2 inch wg

END OF SECTION

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Back-draft dampers.
2. Combination fire-and-smoke dampers.
3. Duct access doors.
4. Dynamic fire dampers.
5. Smoke dampers.
6. Volume control dampers.
7. Flexible duct connections.
8. Dial thermometers.
9. Static pressure gages.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 09 00 - Instrumentation and Control for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
3. Section 23 31 00 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.
4. Division 26: Execution requirements for connection of electrical Combination Smoke and Fire Dampers specified by this section.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

C. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

D. Underwriters Laboratories Inc.:
1. UL 555 - Standard for Safety for Fire Dampers.
2. UL 555S - Standard for Safety for Smoke Dampers.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers and duct access doors.

C. Product Data: Submit data for shop fabricated assemblies and hardware used.

D. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
   1. Fire dampers including locations and ratings.
   2. Smoke dampers including locations and ratings.
   3. Backdraft dampers.
   4. Flexible duct connections.
   5. Volume control dampers.
   6. Duct access doors.

E. Product Data: For fire dampers, smoke dampers and combination fire and smoke dampers submit the following:
   1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
   2. Indicate materials, construction, dimensions, and installation details.
   3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

F. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of access doors and test holes.

C. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.5 QUALITY ASSURANCE

A. Dampers tested, rated and labeled in accordance with the latest UL requirements.

B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect dampers from damage to operating linkages and blades.

C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

D. Storage: Store materials in a dry area indoor, protected from damage.

E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Coordinate Work where appropriate with building control Work.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer’s standard, no less than one year from date of Owner’s acceptance.

1.12 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two of each size and type of fusible link.

PART 2 PRODUCTS

2.1 BACK-DRAFT DAMPERS

A. Manufacturers:
1. Ruskin
2. Air Balance
3. Greenheck
4. Substitutions:[Section 01 60 00 - Product Requirements.

B. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, Galvanized 16 gage thick steel, or extruded aluminum. Blades, maximum 6 inch width, center pivoted, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with

90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

2.2 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
1. Ruskin
2. Air Balance
3. Greenheck
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with NFPA 90A, UL 555, and UL 555S.

C. Fire Resistance: As required by the barrier rating.

D. Leakage Rating: Class II, maximum of 20 cfm at 4 inches wg differential pressure.

E. Damper Temperature Rating: 250 degrees F.

F. Frame: 16 gage, galvanized steel.

G. Blades:
1. Style: Airfoil-shaped, single piece, double skin.
2. Action: Opposed.
3. Orientation: Horizontal.
4. Material: Minimum 16 gage equivalent thickness, galvanized steel.
5. Width: Maximum 6 inches.

H. Bearings: Stainless steel pressed into frame.

I. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.

J. Linkage: Concealed in frame.

K. Release Device: Close in controlled manner and lock damper through actuator closure spring.

L. Operators: UL listed and labeled spring return electric type suitable for 120 volt, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on exterior of duct and link to damper operating shaft.

M. Fusible Link Release Temperature: 165 degrees F.

N. Finish: Mill galvanized.

O. Factory installed sleeve and mounting angles. Furnish silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.

2.3 DUCT ACCESS DOORS

A. Manufacturers:
1. Ruskin
2. Air Balance

3. Greenheck
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
1. Less than 12 inches square, secure with sash locks.
2. Up to 18 inches Square: Furnish two hinges and two sash locks.
3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Furnish additional hinge.
5. Access panels with sheet metal screw fasteners are not acceptable.

2.4 DYNAMIC FIRE DAMPERS

A. Manufacturers:
1. Ruskin
2. Air Balance
3. Greenheck
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with NFPA 90A and UL 555.

C. Fire Resistance: As required by the barrier rating.

D. Dynamic Closure Rating: Dampers classified for dynamic closure to 2000 fpm and 4 inches wg static pressure.

E. Construction:
1. Integral Sleeve Frame: Minimum 20 gage roll formed galvanized steel. Length: 12 inches.
2. Blades:
   a. Style: Curtain type.
   b. Action: Spring or gravity closure upon fusible link release.
   c. Material: Minimum 24 gage roll formed, galvanized steel.
3. Closure Springs: Type 304 stainless steel, constant force type, if required.

F. Fusible Link Release Temperature: 165 degrees F.

G. Mounting: Vertical or horizontal as indicated on Drawings.

H. Duct Transition Connection, Damper Style:
1. B style - rectangular connection, blades out of air stream, high free area.
2. G style - A style connection, grille mounting tabs at end of sleeve for grille.
3. CR style - round connection, sealed.

I. Finish: Mill galvanized.

2.5 SMOKE DAMPERS

A. Manufacturers:
1. Ruskin
2. Air Balance
3. Greenheck
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with NFPA 90A and UL 555S.

C. Leakage Rating: Class II, maximum of 20 cfm at 4 inches wg differential pressure.

D. Damper Temperature Rating: 250 degrees F.

E. Frame: 16 gage, galvanized steel.

F. Blades:
1. Style: Airfoil-shaped, single piece, double skin.
2. Action: Opposed.
3. Orientation: Horizontal.
4. Material: Minimum 14 gage equivalent thickness, galvanized steel.
5. Width: Maximum 6 inches.

G. Bearings: Stainless steel pressed into frame.

H. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.

I. Linkage: Concealed in frame.

J. Operators: UL listed and labeled spring return electric type suitable for 120 volt, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on exterior of duct and link to damper operating shaft.

K. Sleeve: Factory installed 20 gage sleeve, minimum 12 inches long.

L. Finish: Mill galvanized.

2.6 VOLUME CONTROL DAMPERS

A. Manufacturers:
1. Ruskin
2. Air Balance
3. Greenheck
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

C. Splitter Dampers:
1. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.

2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
4. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.

E. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches wg.

F. Quadrants:
1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.7 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:
1. United McGill
2. Semco
3. Tuthill + BAiley
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

C. Connector: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
2. Net Fabric Width: Approximately 3 inches wide.
3. Metal: 3 inch wide, 24 gage galvanized steel.

2.8 DIAL THERMOMETERS

A. Manufacturers:
1. Trerice
2. Ernst
3. Davis
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
1. Size: 3 inch diameter dial.
2. Lens: Clear glass.
3. Accuracy: 1 percent.
4. Calibration: Degrees F.

2.9 STATIC PRESSURE GAGES

A. Manufacturers:
1. Trerice
2. Ernst
3. Davis
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Dial Gages: 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full scale accuracy.

C. Inclined Manometer: Plastic with red liquid on white background with black figures, front calibration adjustment, 3 percent of full scale accuracy.

D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify rated walls are ready for fire damper installation.

C. Verify ducts and equipment installation are ready for accessories.

D. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.

B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.

C. Access Doors: Install access doors at the following locations and as indicated on Drawings:
1. Spaced every 50 feet of straight duct.
2. Upstream of each elbow.
3. Before and after each duct mounted fan.
4. Before and after each automatic control damper.
5. Before and after each fire damper, smoke damper and combination fire and smoke damper.
6. Downstream of each VAV box.
7. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96.

D. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated on Drawings. Review locations prior to fabrication.

1. Mark access doors for fire and smoke dampers on outside surface, with minimum 1/2 inch high letters reading: FIRE/SMOKE DAMPER, SMOKE DAMPER, OR FIRE DAMPER.

E. Install temporary duct test holes where indicated on Drawings and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

F. Install fire dampers, combination fire and smoke dampers and smoke dampers at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
2. Install dampers square and free from racking with blades running horizontally.
3. Do not compress or stretch damper frame into duct or opening.
4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.3 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate re-setting of fire dampers to Owner's representative.

3.4 SCHEDULES

A. Dial Thermometer Location:
1. Each supply air zone.
2. Outside air.
3. Return air.
4. Mixed air.

B. Static Pressure and Filter Gages:
1. Built up filter banks.
2. Supply fan discharge.

END OF SECTION

SECTION 233303 - SOUND ATTENUATORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sound Attenuators.

B. Related Sections:
   1. Section 23 04 00 – General Conditions for Mechanical Trades
   2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
   3. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
   4. Section 23 31 00 – HVAC Ducts and Casings.

1.2 REFERENCES

A. ANSI S12.60 – Acoustical Performance Criteria, Design Requirements and Guidelines for Schools

B. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

C. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

D. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 PERFORMANCE REQUIREMENTS

A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data:
   1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials.
   2. Select sound attenuators based on actual HVAC equipment that is being provided. Review shop drawings for Air Handling Units and Air Terminal Units and provide sound attenuator selections that match the equipment's sound data.
   3. Submit sound data at rated capacity.

C. Manufacturer's Installations Instructions.

D. Provide acoustical system calculations for all duct systems with silencers to demonstrate the silencers shall reduce noise levels from AHU-1, AHU-2 and DOAS-1 to NC and dBa values stated on contract documents (ANSI S12.60). Use sound power levels of actual equipment to be

installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as expressed in the "Sound and Vibration Control" Chapter of the ASHRAE Handbook - HVAC Applications, shall be used. Spaces shall be designed for:

1. Music Room: Maximum dBa of 35.
2. Classrooms and all Learning Environments: Maximum dBa of 35.
3. Multi-Purpose: Maximum dBa of 35
4. Offices: Maximum NC-35.
5. Conference rooms: Maximum NC-35.

E. The manufacturer shall supply certified test data for each scheduled silencer. The data shall include dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same silencer.

F. Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance shall be substantiated by laboratory testing according to ASTM E-477-99 and so certified when submitted for approval. The aero-acoustic laboratory shall be NVLAP accredited for the ASTM E-477-99 test standard. A copy of the accreditation certificate shall be included with the submittals.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

B. Construct ductwork to NFPA 90A standards.

C. Maintain one copy of each document on site.

D. Perform Work in accordance with SMACNA publication as scheduled in Part 3 - Execution.

E. Silencer manufacturer shall operate its own duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with ASTM E-477-99. The facility shall maintain NVLAP accreditation for the E477-99 test standard.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.

C. Maintain temperatures during and after installation of duct sealant.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Vibro-Acoustics.

B. Other manufacturers offering similar products.
1. Industrial Acoustics Company.
2. McGill Airflow.

2.2 MATERIALS

A. Rectangular Silencers: All rectangular silencers shall be constructed with a 22 gauge [18 gauge 16 gauge] galvanized steel outer casing and 26 gauge galvanized perforated steel.

B. Elbow Silencers: All elbow silencers shall be constructed with an 18 gauge galvanized steel outer casing and 22 gauge galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48” shall have at least two half splitters and one full splitter.

C. Vibro-Acoustics Model RMB - Mold Block Acoustic Media: Media shall be MoldBlock MediaTM containing 100% natural cotton fibers treated with an EPA registered, non-toxic borate solution, “flash dried” to actively inhibit the growth of mold, mildew, bacteria and fungi. Media shall not contain any formaldehydes, phenolic resins or Volatile Organic Compounds (VOC’s) that can off-gas and/or cause health concerns. Media shall be 100% recyclable. Media shall comply with UL181 and NFPA 90A. MoldBlock MediaTM shall be packed with a minimum of 15% compression during silencer assembly. Media shall not cause or accelerate corrosion of aluminum or steel. Glass fiber, fiberglass and rock wool will not be permitted as a substitute for MoldBlock MediaTM
1. An alternate acceptable material to Mold Block Acoustic Media is Fiberglass Acoustic Media as specified below with Film Lining.

D. Vibro-Acoustics Model RD - Fiberglass Acoustic Media: Media shall be of acoustic quality, shot-free glass fiber` insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be resilient such that it will not crumble or break, and conform to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.

E. Combustion Ratings: Silencer materials, including acoustic media shall have maximum combustion ratings as noted below when tested in accordance with ASTM E84, NFPA 255 or UL 723.

Flamespread Classification:	15
Smoke Development Rating:	10

2.3 CONSTRUCTION

A. Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in “Section B Materials”, are minimums. Material gauges shall be increased as required for the system pressure and velocity classification. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.

B. Casings shall be lockformed and sealed, except as noted in Section B Materials, to provide leakage-resistant construction. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.

C. All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.

2.4 ACOUSTIC PERFORMANCE

A. Silencer dynamic insertion loss shall not be less than that listed in the schedule.

B. Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with the project’s air distribution system requirements.

C. All silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with the ASTM E-477-99 test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.

2.5 AERODYNAMIC PERFORMANCE

A. Silencer pressure drops shall not exceed those listed in the schedule. Pressure drop measurements shall be made in accordance with the ASTM E-477-99 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

A. Use double nuts and lock washers on threaded rod supports.

B. Install equipment in accordance with manufacturer's instructions, NFPA 90A, and SMACNA publications and guidelines.

3.3 MATERIAL STORAGE ON-SITE

A. All attenuators stored on-site should be elevated from the ground and sealed or covered to protect from moisture and dirt accumulation.

3.4 PROTECTION OF FINISHED WORK

A. Immediately after installation, seal all supply, return and exhaust openings not under immediate work (open ends in ductwork runs) with plastic.

PART 4 ACOUSTIC PERFORMANCE DATA

4.1 NOTES FOR ALL PERFORMANCE DATA

A. Model Number shall be as manufactured by Vibro-Acoustics.

B. Length of elbow silencers shall be centerline dimensions from face of inlet to the face of the outlet.

C. HTL = 10 gauge casing (High Transmission Loss)

D. Type RED shall be elbow type. Type RD shall be straight type. RED and RD Series shall be provided with fiberglass acoustic media as specified above.

E. Type REMB shall be elbow type. Type RMB shall be straight type. RMB and REMB Series shall be provided with mold block acoustic media.

4.2 DYNAMIC INSERTION LOSSES – VAV and CV BOXES

A. Provide sound attenuators at all VAV and CV boxes.

B. Minimum Dynamic Insertion Losses (dB) shall be as scheduled below.

C. Pressure drop data is taken at standard 500 fpm.

D. Insertion Loss Data for sound attenuators is taken at standard 50 fpm; forward flow where the noise and airflow move in same directions.

VAV & CV Types	Model Number	Air Flow (cfm)	Face Dims (in.)	Length (inches)	Press Drop (in.)	HTL	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
1 & 5	RD-LV-F9	400	12x10	36	.08	No	5	7	16	28	39	32	21	13
2 & 6	RD-LV-F9	700	14x14	36	.08	No	5	7	16	28	39	32	21	13
3 & 7	RD-LV-F7	1200	18x18	36	.07	No	6	8	19	28	31	25	17	12
4 & 8	RD-LV-F7	1600	22x22	36	.07	No	6	8	19	28	31	25	17	12
5 & 10	RD-LV-F7	2500	30x24	36	.07	No	6	8	19	28	31	25	17	12

4.3 DYNAMIC INSERTION LOSSES – AIR HANDLING EQUIPMENT (AHU's, DOAS, etc.)

A. Provide sound attenuators at all air handling equipment as scheduled on the drawings. Attenuators shall be provided with the units or field installed.

B. Pressure drop data is taken at standard 500 fpm.

C. Insertion Loss Data for sound attenuators is taken at standard 500 fpm; forward flow where the noise and airflow move in the same directions.

D. Sizes of Attenuators and Minimum Dynamic Insertion Losses (dB) shall be as scheduled below. .

4.4 DYNAMIC INSERTION LOSSES – SPECIFIC SOUND ATTENUATORS

END OF SECTION

SECTION 233400 - HVAC FANS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Downblast centrifugal roof fans.
2. Upblast centrifugal roof fans.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
4. Section 23 09 00 - Instrumentation and Control for HVAC: Product requirements for control components to interface with fans.
5. Section 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
6. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
7. Division 26: Execution and product requirements for connecting equipment specified by this section.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:
1. AMCA 204 - Balance Quality and Vibration Levels for Fans.
2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
4. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit fan manufacturers instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.5 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300 and bear AMCA Certified Sound Rating Seal.

C. Balance Quality: Conform to AMCA 204.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer’s standard, no less than one year from date of Owner’s acceptance.

1.11 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two sets of belts for each fan.

PART 2 PRODUCTS

2.1 DOWNBLAST CENTRIFUGAL ROOF FANS

A. Manufacturers:
1. Greenheck Corp.
2. Loren Cook Company
3. Twin City
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fan Unit: Downblast type. V-belt or direct drive, with spun aluminum housing; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Motor: Totally enclosed fan cooled.

E. Roof Curb: 12 inch high self-flashing of aluminum construction with continuously welded seams, 1 inch insulation and curb bottom, hinged curb adapter, and factory installed nailer strip.

F. Disconnect Switch: Factory wired, non-fusible, in fan housing for thermal overload protected motor, NEMA 250 Type 4 enclosure.

G. Accessories:
1. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return.
2. Fan speed controller.

H. Performance:
1. Refer to schedules on Construction Drawings.

I. Electrical Characteristics and Components:
1. Refer to schedules on Construction Drawings.

2.2 UPBLAST CENTRIFUGAL ROOF FANS

A. Manufacturers:
1. Greenheck Corp.
2. Loren Cook Company
3. Twin City
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fan Unit: Upblast type. V-belt or direct drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Motor: Totally enclosed fan cooled.

E. Roof Curb: 24 inch high self-flashing of aluminum construction with continuously welded, ventilated double wall, hinged curb adapter, and factory installed nailer strip.

F. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 4 enclosure.

G. Accessories:
1. Fan speed controller.

H. Performance:
1. Refer to schedules on Construction Drawings.

I. Electrical Characteristics and Components:
1. Refer to schedules on Construction Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify roof curbs are installed and dimensions are as shown on shop drawings.

3.2 INSTALLATION

A. Secure roof with cadmium plated steel lag screws to roof curb.

B. Install backdraft dampers on inlet to roof exhaust.

C. Provide sheaves required for final air balance.

3.3 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer’s field services.

B. Furnish services of factory trained representative for minimum of one days to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate fan operation and maintenance procedures.

3.5 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 233600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Variable volume terminal units.

B. Related Sections:
   1. Section 23 04 00 – General Conditions for Mechanical Trades
   2. Section 23 09 00 - Instrumentation and Control for HVAC: Product requirements for control components to interface with air terminal units.

1.2 REFERENCES

A. American Refrigeration Institute:
   1. ARI 880 - Air Terminals.
   2. ARI 885 -Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

B. Underwriters Laboratories Inc.:
   1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, [heating coil capacity] and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.

C. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of units and controls components.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

1.5 QUALITY ASSURANCE

A. Test and rate air terminal units performance for air pressure drop, flow performance, and acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each terminal unit.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer’s standard, no less than one year from date of Owner’s acceptance.

PART 2 PRODUCTS

2.1 SINGLE DUCT VARIABLE VOLUME AIR TERMINAL UNITS

A. Manufacturers:
1. Krueger
2. Price
3. Titus
4. The Trane Co.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Variable air volume terminal units for connection to central air systems, with electronic controls and hot water heating coils.

C. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.

D. Basic Assembly:
   1. Casings: Minimum 22 gage galvanized steel.
   2. Lining: Minimum 1 inch thick neoprene or vinyl coated glass fiber insulation, 1.5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.
   3. Plenum Air Inlets: Round stub connections for duct attachment.
   4. Plenum Air Outlets: S slip-and-drive connections.

E. Basic Unit:
   1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
   2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches rated inlet static pressure.
   3. Mount damper operator to position damper normally open.

F. Hot Water Heating Coil:
   1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.
   2. Capacity: Refer to schedules on Construction Drawings.

G. Automatic Damper Operator:
   1. Electric Actuator: 24 volt with high limit and remote temperature read and reset capability.

H. Sound Ratings: Not to exceed 35 NC at 1 in-wg static pressure.

I. Thermostat: Electronic type with appropriate mounting hardware. Refer to Section 23 09 00.

J. Sequence of Operation: Refer to Section 23 09 93.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify ductwork is ready for air terminal installation.

3.2 INSTALLATION

A. Connect to ductwork in accordance with Section 23 31 00.

B. Install ceiling access doors or locate units above easily removable ceiling components.

C. Support units individually from structure. Do not support from adjacent ductwork.

D. Install minimum of 10 ft of 1 inch thick lined ductwork downstream of units. Refer to Section 23 31 00.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 30 percent full flow. Set units with heating coils for minimum 30 percent full flow.

END OF SECTION

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Diffusers.
   2. Registers
   3. Grilles.

B. Related Sections:
   1. Section 23 04 00 – General Conditions for Mechanical Trades
   2. Section 23 33 00 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.2 REFERENCES

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

B. Sheet Metal and Air Conditioning Contractors:
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

C. Test Reports: Rating of air outlet and inlet performance.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer's standard, no less than one year from date of Owner's acceptance.

1.9 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish 5 percent extra air outlets and inlets.

PART 2 PRODUCTS

2.1 RECTANGULAR CEILING DIFFUSERS

A. Manufacturers:
1. E. H Price Company
2. Krueger
3. Titus
4. Tuttle and Bailey
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Type: Square and rectangular, multi-louvered diffuser to discharge air in four-way pattern.

C. Frame: Inverted T-bar.

D. Fabrication: Steel with baked enamel off-white finish.

2.2 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:
1. E. H Price Company
2. Krueger
3. Titus
4. Tuttle and Bailey
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, horizontal face.

C. Frame: 1-1/4 inch margin with concealed mounting.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white enamel finish.

2.3 WALL SUPPLY REGISTERS/GRILLES

A. Manufacturers:
1. E. H Price Company
2. Krueger
3. Titus
4. Tuttle and Bailey
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, horizontal face, double deflection.

C. Frame: 1-1/4 inch margin with concealed mounting and gasket.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white enamel finish.

2.4 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:
1. E. H Price Company
2. Krueger
3. Titus
4. Tuttle and Bailey
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, horizontal face.

C. Frame: 1-1/4 inch margin with concealed mounting.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white enamel finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify inlet and outlet locations.

C. Verify ceiling and wall systems are ready for installation.

3.2 INSTALLATION

A. Install diffusers to ductwork with airtight connection.

B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00.

C. Do not locate air registers, diffusers or grilles in floors of toilet or bathing rooms.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION

SECTION 235234 - HOT WATER CONDENSING BOILERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Hot Water Condensing Boilers.
2. Boiler controls.
3. Boiler trim.
4. Natural gas fired burner.

B. Related Sections:
1. Division 3 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolators for placement by this section.
5. Section 23 21 13 - Hydronic Piping: Execution requirements for hot water piping for piping connections to boilers specified in this section.
6. Division 26 : Execution requirements for electric connections to boilers specified in this section.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI Z21.13 - Gas-fired Low Pressure Steam and Hot Water Boilers.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. American Society of Mechanical Engineers:
1. ASME Section I - Boiler and Pressure Vessel Code - Power Boilers.
2. ASME Section IV - Boiler and Pressure Vessel Code - Heating Boilers.
3. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. Hydronics Institute:
1. H.I. Heating Boiler Standard - Testing and Rating Standard for Heating Boilers.

E. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. National Fire Protection Association:
1. NFPA 54 - National Fuel Gas Code.
2. NFPA 58 - Liquefied Petroleum Gas Code.

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit capacities and accessories included with boiler. Include general layout, dimensions, size and location of water, fuel, electric and vent connections, electrical characteristics, weight and mounting loads.

C. Test Reports: Indicate boilers meet or exceed specified performance and efficiency. Submit results of combustion test.

D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Manufacturers Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 - Closeout procedures.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.5 QUALITY ASSURANCE

A. Conform to ASME Section IV for construction of boilers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

B. Boiler Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with H.I. Heating Boiler Standard.

C. Gas Train and Safety Controls: Conform to requirements of GEGAP.

D. Unit Certification: AGA, UL certified.

E. Conform to applicable code for internal wiring of factory wired equipment.

F. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for purpose specified and indicated.

G. Perform Work in accordance with State of Connecticut.

H. Maintain two copies of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

A. Division 1 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Division 1 - Product Requirements: Product storage and handling requirements.

B. Accept boilers and accessories on site in factory shipping packaging. Inspect for damage.

C. Protect boilers from damage by leaving packing in place until installation.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Division 1 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

C. Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Fire-Tube Condensing Boilers
      a. The pressure vessel/heat exchanger shall carry a 10-year from shipment, 7 year full, 3 year prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
      b. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years.
      c. All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 18 months.

1.11 MAINTENANCE SERVICE

A. Division 1 - Execution and Closeout Requirements: Maintenance service.

B. Furnish service and maintenance of boilers for 18 months from Date of Substantial Completion.

C. Provide emergency call back service at all hours for this maintenance period.

D. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

E. Perform maintenance work using qualified personnel under supervision of boiler manufacturer.

1.12 MAINTENANCE MATERIALS

A. Division 1 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish wire brush and handle for fire tube boiler cleaning.

PART 2 PRODUCTS

2.1 BUILDING HEATING HOT WATER CONDENSING BOILERS

A. Manufacturers:
1. Aerco Benchmark
2. Lochinvar Crest
3. Cleaver Brook Clearfire
4. No Substitutions will be accepted

B. General: Basis of design piping diagram is shown on plan to be piped so as to have the boilers acceptance is of the full flow of the system. If alternate manufacturer is submitted on revised piping diagram shall be submitted with boiler information sheets. All additional work associated with alternate boiler submittals shall be in accordance with 230400 and result in no additional cost to the owner. If alternate boilers require different piping arrangement this is acceptable(if and only if efficiency remains as described below), all additional piping, accessories and pumps shall be included on submitted revised piping diagram with note stating that attached revisions will not result in additional cost to owner. Boilers to be supplied with on-board controls for complete control as described in 230993 provide interface with building management system as described in 230993.

C. Performance: Thermal efficiency of the boilers will vary with return temperature and firing rate, and the boiler will be capable of condensing operation and up to 99% efficiency when return water to the boiler is 130°F and lower. When tested to the requirements of the Department of Energy as codified in 10 CFR 431, boiler efficiency will be 94%. Boiler will have no minimum return water temperature and no minimum flow rate requirement. Piping to the boilers may be primary only with no dedicated primary boiler water pump required. The boiler shall be design tested and certified by independent test agency to a recognized boiler test standard. Boiler will be equipped to meet the requirements of CSD-1 and FM.

D. Heat exchanger construction: The boiler shall be constructed and stamped to ASME requirements and National Board Listed for a maximum allowable working pressure of 125 psi (150 psi). The boiler will be of a steel vertical fire tube ; the condensing fire tubes will be fabricated from duplex stainless steel.

E. The burner shall be constructed from high-grade stainless steel for universal use with natural gas or propane gas. Burner ignition shall be by a direct spark ignition system. The boiler shall be equipped with a digital boiler control unit interface. The burner shall be capable of operating at altitudes of up to 10,000 ft (3,000 m) without change of orifices, but with the use of an electronic coding card.

F. Boiler temperature control: Temperature control on each boiler shall be accomplished by a electronic operator with LED readout. This operator shall be fully programmable at its keypad and through memory card. Operator shall have the ability to security code protect select parameters or full keyboard lock. Freeze protection, nighttime setback and outdoor reset are standard features of the operator. Electronic operating control shall have a 485 serial connection using MODBUS protocol for remote read and write of all parameters in the operating control. The operator shall provide continuous monitoring and display of both inlet and outlet water temperatures.

G. Provide a system integration controller for Lead/Lag Control of up to 8 boilers through 485 serial.

H. Vent requirements and capabilities: Venting shall be side wall horizontal or vertical sealed (direct vent) chimney system. The boiler shall operate under Category IV positive vent pressure conditions for room air dependent operation. Venting material for room air dependant operation shall be stainless steel UL approved venting system for positive pressure or CPVC ULC S636 listed material.

I. The steel jacket shall be coated with a baked-on finish. Pressure vessel will be insulated with 2 inches of heavy density fiberglass. The boiler will fit properly in the space provided and the installation will conform to all local, state and national codes.

2.2 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Division 26 and per schedule:

PART 3 EXECUTION

3.1 INSTALLATION

A. Install boilers plumb and level, to plus or minus 1/16 inch over boiler base.

B. Maintain manufacturer's recommended clearances around and over boilers.

C. Install boiler on concrete housekeeping pad, minimum 4 inches high and 6 inches larger than boiler base on each side. Refer to Division 3 .

D. Install boiler on vibration isolators in accordance with Section 23 05 48.

E. Connect hot water piping to supply and return boiler connections.

F. Install the following piping accessories. Refer to Section 23 21 13.
   1. On supply:
      a. Per Piping Details.
   2. On return:
      a. Per Piping Details.

G. Install discharge piping from relief valves and drain valves to nearest floor drain.

H. Install circulator and diaphragm expansion tank on boiler.

I. Install boiler trim and accessories furnished loose for field mounting.

J. Install electrical devices furnished loose for field mounting.

K. Install control wiring between boiler mounted control panel, BMS-2 control panel and field mounted control devices.

L. Connect flue to boiler outlet, full size of outlet.

M. All aspects of installation of boiler plant shall be in strict accordance with manufacturer’s instructions.

3.2 FIELD QUALITY CONTROL

A. Division 1 - Quality Requirements, Division 1 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform combustion test including boiler firing rate, over fire draft, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide, percent oxygen, percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output. Perform test at minimum, mid-range, and high fire.

C. Arrange with local authorities having jurisdiction for inspection of all boilers, piping, and for certificate of operation.

3.3 MANUFACTURER’S FIELD SERVICES

A. Start-up boilers according to manufacturer's start-up instructions and in presence of boiler manufacturer's representative Test controls and demonstrate compliance with requirements. Adjust burner for maximum burning efficiency. Replace damaged or malfunctioning controls and equipment.

3.4 ADJUSTING

A. All heating equipment shall be adjusted as per manufacturer’s requirements.

3.5 CLEANING

A. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

3.6 DEMONSTRATION

A. Division 01 79 00- Demonstration and training.

B. Refer to Section 23 0400, for additional training documentation and training requirements.

C. Demonstrate operation and maintenance procedures.

D. Furnish services for manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of boilers. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer prior to training date.

END OF SECTION

SECTION 236411 - PACKAGE WATER CHILLERS - RECIPROCATING, SCROLL, AND SCREW

PART 1 GENERAL

1.1 SUMMARY

A. Section includes chiller package, charge of refrigerant and oil, controls and control connections, chilled water connections, condenser water connections, refrigerant connections, auxiliary water connections, starters.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
5. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for chillers specified in this section.
6. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and condenser water piping for placement by this section.
7. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for piping specialties for placement by this section.
8. Section 23 23 00 - Refrigerant Piping: Product requirements for refrigerant piping for placement by this section.
9. Division 26: Execution requirements for connection to chillers specified by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
1. ARI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. American Society of Mechanical Engineers:
1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

1.3 DEFINITIONS

A. Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

B. Integrated Part-Load Value (IPLV): A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections. Indicate valves, strainers, and thermostatic valves required for complete system.

C. Product Data: Submit rated capacities, weights, specialties and accessories, electrical requirements, wiring diagrams, and control diagrams.

D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include startup instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements including those furnished but not produced by manufacturer.

F. Manufacturer’s Field Reports: Submit start-up report for each unit. Indicate results of leak test and refrigerant pressure test.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

1.6 QUALITY ASSURANCE

A. Conform to ARI 550/590 code for testing and rating of screw water chillers.

B. Performance Ratings: Coefficient of Performance (COP) and Integrated Part-Load Value (IPLV) not less than prescribed by ASHRAE 90.1.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept chillers on site in factory packaging. Inspect for damage.

C. Protect indoor chillers from weather by storing under roof.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty to include coverage for complete assembly including materials and labor.

PART 2 PRODUCTS

2.1 PACKAGED WATER CHILLERS

A. Manufacturers:
1. Carrier Corp.
2. The Trane Company
3. York
4. Daiken
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Factory assembled and tested, packaged, water cooled, liquid chillers consisting of semi-hermetic screw compressors, compressor motor, condensers, evaporator, refrigeration accessories, instrument and control panel including gages and indicating lights, auxiliary components and accessories, and motor starters.

2.2 SEMI-HERMETIC COMPRESSORS

A. Screw Compressors:
1. Unit: Direct drive, semi-hermetic 3600 RPM, fixed compression, rotary screw compressor with control panel.
2. Features: Differential refrigerant pressure oil pump, oil heater, oil separator and filter and oil charging valve.
3. Motor: Suction gas-cooled, hermetically sealed, squirrel cage induction.
4. Automatic Capacity Reduction: Continuously variable slide valve with infinitely variable control to 25 percent of full load.

2.3 EVAPORATOR

A. Shell and tube type, seamless or welded steel construction with cast iron or fabricated steel, heads, seamless copper tubes or red brass tubes with integral fins, rolled or silver brazed into tube sheets. Furnish multiple refrigerant circuits on multiple compressor units.

B. Design, test, and stamp refrigerant side for 225 psig working pressure and water side for 150 psig working pressure, in accordance with ASME Section VIII.

C. Insulate with 0.75 inch minimum thick flexible insulation with maximum K factor of 0.26.

D. Furnish water drain connection and thermometer wells for temperature controller and low temperature cutout.

2.4 CONDENSER COILS, FANS AND MOTORS

A. Coils: Aluminum fins brazed to a microchannel heat exchanger. Furnish sub-cooling circuits as applicable. Air test under water to 425 psig, and [vacuum] dehydrate. Seal with holding charge of refrigerant.

B. Coil Guard: Louvered with lint screens.

C. Configuration: Two refrigeration circuits each.

D. Vertical direct driven propeller type condenser fans with fan guard on discharge, equipped with roller or ball bearings with grease fittings extended to outside of casing.

E. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built-in current and thermal overload protection

2.5 REFRIGERANT CIRCUIT

A. Factory furnished and piped.

B. Furnish for each refrigerant circuit:
1. Liquid line solenoid valve.
2. Filter dryer (replaceable core type).
3. Liquid line sight glass and moisture indicator.
4. Thermal expansion for maximum operating pressure.
5. Charging valve.
6. Insulated suction line.
7. Discharge line check valve.
8. Compressor discharge service valve.
9. Pressure relief device.

2.6 CONTROLS

A. On or near chiller, mount steel control panel with NEMA 250 Type 3R enclosure, containing starters, power and control wiring, molded case disconnect switch, factory wired with single point power connection.

B. For each compressor, furnish across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for control power. Furnish manual reset, current overload protection.

C. Furnish devices on control panel face:
1. Compressor, run lights.
2. System start-stop switch.
3. Control power fuse of circuit breaker.
4. Compressor lead-lag switch.
5. Demand limit switch.

D. Furnish safety controls with indicating lights arranged so machine is shut down and requires manual reset:
1. Low chilled water temperature switch.

2. High discharge pressure switch for each compressor.
3. Low suction pressure switch for each compressor.
4. Oil pressure switch.
5. Flow switch in chilled water line.
6. Flow switch in condenser water line.
7. Relay for remote mounted emergency shutdown.

E. Furnish the following operating controls:
1. Multi-step chilled water temperature controller to cycle compressor and activate capacity controls.
2. Five minute off timer prevents compressor from short cycling.
3. Part winding start timer.
4. Periodic pump-out-timer to pump down on chilled water flow and high evaporator refrigerant pressure.
5. Thermostat to cycle fan motors in response to out-door ambient temperature.
6. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
7. Solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.
8. Load limit thermostat to limit compressor loading on high return water temperature.
9. Three phase monitor to protect unit by stopping compressor on phase loss, phase reversal, phase unbalance, or under voltage.
10. Cycle counter and operating hour meter.

F. Furnish pre-piped gage board with pressure gages for suction and discharge refrigerant pressures, and oil pressures for each compressor.

G. Furnish alarm package with test button and lights indicating control circuit is energized, compressor is running, and sounds audible alarm and activates indicating light upon detection of compressor malfunction, low chilled water temperature, or evaporator water flow failure.

H. For multiple units, furnish remote mounted sequence panel to allow operation in parallel with lead-lag switching.

2.7 CHILLER PERFORMANCE

A. Refer to schedules on Construction Drawings.

2.8 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Refer to schedules on Construction Drawings.

2.9 SOURCE QUALITY CONTROL (AND TESTS)

A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.

B. Furnish testing and analysis of package chillers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install packaged outdoor chiller on concrete foundation minimum 6 inches thick and 6 inches wider than equipment base on each side. Refer to Section 03 30 00.

B. Install the following piping accessories on evaporator chilled water piping connections. Refer to Section 23 21 16 and Section 23 21 13.
   1. On inlet:
      a. Thermometer well for temperature controller.
      b. Thermometer.
      c. Strainer.
      d. Flow switch.
      e. Flexible pipe connection.
      f. Pressure gage.
      g. Shut-off valve.
   2. On outlet:
      a. Thermometer.
      b. Flexible pipe connection.
      c. Pressure gage.
      d. Shut-off and balancing valve.

C. Install auxiliary water piping for oil cooling units and purge condensers.

D. Arrange piping for easy dismantling to permit tube cleaning.

E. Install chiller accessories furnished loose for field mounting.

F. Install electrical devices furnished loose for field mounting.

G. Install control wiring between chiller control panel and field mounted control devices.

H. Provide connection to electrical service. Refer to Division 26.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Furnish cooling season start-up, winter season shutdown service, for first year of operation. When initial start-up and testing takes place in winter and machines are to remain inoperative, repeat start-up and testing operation at beginning of first cooling season.

3.3 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.

B. Furnish services of factory trained representative for minimum of one days to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.

C. Furnish initial charge of refrigerant and oil.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

3.5 DEMONSTRATION AND TRAINING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate system operations and verify specified performance. Demonstrate low ambient operation during winter testing for air-cooled condensers.

END OF SECTION

SECTION 237413 - OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes modular factory fabricated air-handling units and accessories.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
4. Section 23 07 00 - HVAC Insulation: Product requirements for insulation for placement by this section.
5. Section 23 09 00 - Direct-Digital Control System for HVAC: Controls remote from unit.
6. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
7. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and hot water piping connections to air handling units.
8. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
9. Section 23 33 00 - Air Duct Accessories: Product requirements for flexible duct connections for placement by this section.
10. Division 26: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. Air Movement and Control Association International, Inc.:
1. AMCA 99 - Standards Handbook.
2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
4. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
5. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. Air-Conditioning and Refrigeration Institute:
1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
2. ARI 430 - Central-Station Air-Handling Units.

D. ASTM International:
1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

E. Underwriters Laboratories Inc.:
1. UL 900 - Air Filter Units.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

C. Product Data, Submit the following:
1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
3. Fans: Performance and fan curves with specified operating point plotted, power, RPM.
4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
5. Dampers: Include leakage, pressure drop, and sample calibration curves. Indicate materials, construction, dimensions, and installation details.
6. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.

D. Manufacturer's Installation Instructions: Submit.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 QUALITY ASSURANCE

A. Damper Leakage: Test in accordance with AMCA 500.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for air handling units.

1.10 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish one set of fan belts for each unit.

C. Furnish one set of filters for each unit.

PART 2 PRODUCTS

2.1 AIR HANDLING UNITS

A. Manufacturers:
1. Trane
2. York International
3. Carrier
4. Daiken
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Configuration: Fan section plus accessories, including:
1. Cooling coil section.
2. Heating coil.
3. Filter section.
4. Combination filter/mixing box section.

C. Performance Base: Sea level pressure or altitude.

D. Fabrication: Conform to AMCA 99 and ARI 430.

E. Roof Curb: Refer to Section 23 05 48.

2.2 CASING

A. Channel base and drain pan of welded steel. Assemble sections with gaskets and bolts.

B. Outside Casing:
1. Galvanized Steel: 0.0635 inch.
2. Seal fixed joints with flexible weather tight sealer. Seal removable joints with closed-cell foam gasket.
3. Furnish cap strips over roof flanges. Furnish rain caps and gaskets on access doors.

C. Outside Casing Finish:
   1. Baked enamel.
   2. Finish exceeds 500 hour salt spray test in accordance with ASTM B117.
   3. Color: Manufacturer's standard.

D. Inside Casing:
   1. Galvanized Steel: Solid, 0.0276 inch thick.

E. Floor Plate:
   1. Galvanized Steel: 1.382 inch thick.

F. Insulation: Neoprene coated, glass fiber, applied to internal surfaces with adhesive and weld pins with exposed edges of insulation coated with adhesive.
   1. 'K' factor at 75 degrees F: Maximum 0.26 Btuh inch/ sq ft/ degrees F.
   2. Density: 2 inch thick, 1-1/2 lbs/cu ft.

G. Walk-in Access Doors: 24 x 48 inch Galvanized steel insulated sandwich construction, for flush mounting, with hinges, gasket, latch, and handle assemblies, and 12 x 12 inch inspection window of 1/4 inch thick Plexiglas.

H. Lights: Located in accessible sections suitable for damp locations with wire guards, factory wired to weatherproof switch and pilot light and duplex outlet mounted on casing exterior.

I. Drain Pans: Double thickness galvanized steel with welded corners. Cross break and pitch to drain connection. Furnish drain pans under heating coil section and cooling coil section.

J. Bottom Inlet Units: Furnish steel or aluminum walking grate on structural supports.

K. Strength: Furnish structure to brace casings for suction pressure of 2.5 inch wg, with maximum deflection of 1 in 200.

L. Louvers: Stationary, of galvanized steel, 4 inch deep with plenum, 1/2 inch mesh, 0.04 inch galvanized wire bird screen in galvanized frame, and bearing AMCA Certified Ratings Seal in accordance with AMCA 500. Furnish adjustable louvers with hollow vinyl bulb edging on blades and foam side stops to limit leakage to maximum 2 percent at 4 inch wg differential pressure when sized for 200 fpm face velocity.

M. Pipe Cabinets
   1. External Pipe Cabinets
      a. The AHU Manufacturer shall provide external pipe cabinet assemblies as indicated on the schedule and drawings. External pipe cabinets shall be factory assembled and shipped with the units for field mounting. Pipe cabinet walls shall be double wall construction. Cabinet interior and exterior walls panels shall be of the same construction as the unit interior and exterior wall panels, respectively. Cabinet interior ceiling and exterior roof panels shall be of the same construction as the unit interior ceiling and exterior roof panels, respectively. Cabinet roofs shall be sloped away from the unit for water drainage.
      b. External pipe cabinets shall be provided with doors as indicated on the schedule and drawings. Doors shall be double wall construction. Interior and exterior cabinet door panels shall be of the same construction as the unit interior and exterior door panels, respectively.

c. Insulation that meets a minimum R-value of 25.0 shall be provided throughout all external pipe cabinet assemblies, including pipe cabinet doors. Insulation shall be injected foam. Foam shall be closed cell to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the wall, ceiling, and door cavities in all directions so that no voids exist and settling of insulation is prevented. Pipe cabinet assemblies shall comply with NFPA 90 A.

2.3 FANS

A. Type: Air foil, double width, double inlet, centrifugal type fan.

B. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301, tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

D. Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing with copper tube and grease fitting rigidly attached to casing.

E. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Furnish access to motor, drive, and bearings through removable casing panels or hinged access doors. Furnish built-in inertia base of welded steel with bottom sheet and reinforcing grid for concrete ballast. Mount base on vibration isolators.

F. Fan Modulation: Variable Frequency Drive.

2.4 MOTORS

A. Refer to Section 23 05 13 for motor requirements.

2.5 BEARINGS AND DRIVES

A. Bearings: Pillow block type, self-aligning, grease-lubricated ball bearings, with ABMA 9 L-10 life at 50,000 hours.

B. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

C. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.

D. Belt Guard: Fabricate to SMACNA Standard; 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.6 COILS

A. Casing with access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.

C. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.

D. Fabrication:
1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
2. Fins: Aluminum.
3. Casing: Die formed channel frame of galvanized steel.

E. Water Heating Coils:
1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.

F. Water Cooling Coils:
1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

2.7 FILTERS

A. Filter Box: Section with filter guides, access doors from both sides, for side loading with gaskets and blank-off plates.

B. Filter Media: UL 900 listed, Class I.

C. Flat: 2 inches deep disposable panel filters.

D. Filter Gauges: One piece molded plastic inclined manometer, with static pressure tips.

2.8 ECONOMIZER

A. Provide economizer components and controls in accordance with ICC IECC.

2.9 DAMPERS

A. Mixing Boxes: Section with factory mounted outside and return air dampers of galvanized steel with vinyl bulb edging and edge seals in galvanized frame, with galvanized steel axles in self-lubricating brass bearings, in opposed blade arrangement with damper blades positioned across short air opening dimension. Furnish removable, full width support for freeze-protection thermostat, with removable end panel to permit support removal.

B. Outside Air Damper Leakage: Maximum 3.0 cfm per square foot at 1. inches wg pressure differential.

C. Damper Leakage: Maximum 2 percent at 4 inch wg differential pressure when sized for 2000 fpm face velocity.

D. Damper Actuators: Furnish factory installed electronic damper actuators for outside air, return air, and exhaust air dampers.

2.10 Energy Recovery Ventilation (ERV) Wheels

A. Manufacturers level of quality: Novel Air and DRI.

B. Total energy recovery wheels shall be provided as indicated on the schedule and drawings. Wheels shall be integral parts of the AHUs and shall be sized per the ventilation requirement of the units. Additional outside air units, or other field assembled and ducted energy recovery devices, are not acceptable. Mixed air units with economizing shall be constructed with internal bypass dampers such that the pressure drop across the wheel does not increase during economizing. External bypass and multiple duct connections are not acceptable.

C. The energy recovery wheel shall be certified to ANSI/AHRI Standard 1060 and bear the AHRI 1060 label. Performance characteristics of the energy wheel shall be provided as defined by AHRI 1060 definitions. The energy wheel shall be a total energy wheel, with the sensible and latent effectiveness reported and within 5% of each other. The calculated total net effectiveness of the recovery wheel shall not be less than 70% when the specified ventilation flow rate equals the exhaust flow rate. The energy wheel's EATR shall be less than the value indicated in the schedule and drawings. The amount of outside air transferred to the exhaust air shall also be reported to ensure proper fan and damper sizing. Wheel face velocity shall not exceed 900 fpm and pressure drops shall be less than 1.25" w.g.

D. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belts. The energy wheel media shall be constructed of synthetic fiber or polymer media. The media shall not be subject to corrosion in marine or coastal environments. The adsorbent shall be integrally bound into the media or impregnated into the media without the use of binders or adhesives. The adsorbent shall not be applied as a glued on surface coating and not susceptible to erosion, abrasion, or delamination. The adsorbent shall be selected for its high affinity for water vapor and shall not dissolve or deliquesce in the presence of water or high humidity. Energy recovery cassettes shall be UL-recognized components certified for mechanical, electrical and fire safety in accordance with UL Standard 1812.

E. All diameter and perimeter seals shall be provided as part of the cassette assembly. Perimeter seals shall be self-adjusting and diameter seals shall be adjustable. Seals shall be factory set.

F. Wheel drive motor shall be provided mounted in the cassette frame. Motor locations shall be as indicated on the schedule and drawings. Wheel drive motor shall be thermally protected and UL Component Recognized. Drive belts shall not require belt tensioners. Wheel motors shall be of the voltage, phase, frequency, and Hp indicated on the schedule and drawings. Wheels shall have flanged or pillow block bearings which support the rotating shaft of the wheel. Outboard bearings shall be provided with grease fittings for periodic lubrication. L-10 bearing life shall be greater than 400,000 hours at design conditions.

G. Access doors shall be provided for the removal of wheel segments. Doors shall be located to allow access to the entire upstream and downstream face of each wheel. Adequate space and access shall be provided for energy wheel motor, bearing and belt removal.

H. Energy recovery wheels shall be designed with variable effectiveness control, to vary the wheel's recovery capacity. Variable effective control shall be done by an internal bypass damper provided by the AHU Manufacturer. The wheel's variable effectiveness control shall have the ability to modulate the total energy recovery ability down to at least 40% of the initial recovery capacity. Variable frequency speed control is not an acceptable method for controlling variable effectiveness.

I. Frost prevention shall be achieved by outside air bypass, return air preheat, or outside air preheat, depending upon design conditions. Frost set point temperatures based on the scheduled design air conditions shall be provided by the AHU Manufacturer. Variable frequency speed control is not an acceptable method of frost control. Winter design supply and exhaust air conditions leaving the energy wheel shall be provided by the AHU Manufacturer and shall include any de-rate in performance due to frost prevention measures.

2.11 CONTROLS

A. Controls: Refer to Section 23 09 00. Refer to Section 23 09 93 for sequence of operation.

2.12 CAPACITY

A. Refer to schedules on the Construction Drawings.

2.13 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Refer to schedules on Construction Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify roof curbs are installed and dimensions are as shown on shop drawings.

3.2 INSTALLATION

A. Install in accordance with ARI 430.

B. Install flexible connections between unit and inlet and discharge ductwork. Install metal bands of connectors parallel with minimum 1 inch flex between ductwork and fan while running. Refer to Section 23 33 00.

C. Install assembled units with vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as required. Adjust snubbers to prevent tension in flexible connectors when fan is operating. Refer to Section 23 05 48.

D. Install condensate piping with trap and route from drain pan to splash block on roof. Refer to Section 23 21 13.

E. Provide sheaves required for final air balance.

F. Insulate coil headers located outside airflow as specified for piping. Refer to Section 23 07 00.

3.3 INSTALLATION CHILLED WATER COOLING COIL

A. Make connections to coils with unions or flanges.

B. Connect water supply to leaving airside of coil (counter flow arrangement).

C. Locate water supply at bottom of supply header and return water connection at top.

D. Install water coils to allow draining and install drain connection at low points.

E. Install the following piping accessories on chilled water piping connections. Refer to Section 23 21 16 and Section 23 21 13.
   1. On supply:
      a. Thermometer well and thermometer.
      b. Well for temperature sensor.
      c. Shutoff valve.
      d. Strainer.
      e. Control valve.
      f. Pressure gage.
   2. On return:
      a. Thermometer well and thermometer.
      b. Well for temperature sensor.
      c. Pressure gage.
      d. Shutoff valve.
      e. Balancing valve.

F. Install manual air vents at high points complete with shutoff valve. Refer to Section 23 21 13.

G. Install chilled water piping accessories within unit casing.

3.4 INSTALLATION HOT WATER HEATING COIL

A. Make connections to coils with unions or flanges.

B. Connect water supply to leaving airside of coil (counter flow arrangement).

C. Locate water supply at bottom of supply header and return water connection at top.

D. Install water coils to allow draining and install drain connection at low points.

E. Install the following piping accessories on hot water piping connections. Refer to Section 23 21 16 and Section 23 21 13.
   1. On supply:
      a. Thermometer well and thermometer.
      b. Well for temperature sensor.
      c. Shutoff valve.
      d. Strainer.
      e. Control valve.
      f. Pressure gage.

2. On return:
   a. Thermometer well and thermometer.
   b. Well for temperature sensor.
   c. Pressure gage.
   d. Shutoff valve.
   e. Balancing valve.

F. Install manual air vents at high points complete with shutoff valve. Refer to Section 23 21 13.

G. Install hot water piping accessories within unit casing.

3.5 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer’s field services.

B. Furnish services of factory trained representative for minimum of one day to leak test, start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.6 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Vacuum clean coils and inside of unit cabinet.

C. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.7 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate unit operation and maintenance.

C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.8 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 238200 - CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Unit heaters.
2. Cabinet unit heaters.
3. Hydronic radiant heaters.

B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 21 13 - Hydronic Piping: Execution requirements for connection of chilled water, hot water, and drain piping to units specified by this section.
3. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
4. Division 26: Execution requirements for electric connection to units specified by this section.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations. Indicate schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers.

C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.

D. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access to valves.

C. Operation and Maintenance Data: Submit manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

D. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

E. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.4 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept units on site in factory packing. Inspect for damage. Store under roof.

C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.7 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Manufacturer’s standard, no less than one year from date of Owner’s acceptance.

PART 2 PRODUCTS

2.1 UNIT HEATERS

A. Manufacturers:
1. Vulcan
2. McQuay
3. Modine
4. Trane
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Coils: Seamless copper tubing, 0.025 inch minimum wall thickness, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

C. Casing: 0.0478-inch thick steel with threaded pipe connections for hanger rods.

D. Finish: Factory applied baked enamel of manufacturer’s standard color.

E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

F. Air Outlet: Adjustable pattern diffuser on projection models and two-way louvers on horizontal throw models.

G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. Refer to Section 23 05 13.

H. Control: Local multi-speed disconnect switch.

I. Capacity: Refer to schedules on Construction Drawings.

J. Electrical Characteristics:
1. Refer to schedules on Construction Drawings.

2.2 CABINET UNIT HEATERS

A. Manufacturers:
1. Trane
2. Vulcan
3. McQuay
4. Modine
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 100 psi and 220 degrees F.

C. Cabinet: 0.0598 inch thick steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation and integral air outlet and inlet grilles.

D. Finish: Factory applied baked enamel of manufacturer’s standard color on visible surfaces of enclosure or cabinet.

E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.

F. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.

G. Control: Multiple speed switch, factory wired, located in cabinet.

H. Filter: Easily removed 1 inch thick glass fiber throw-away type, located to filter air before coil.

I. Capacity: Refer to schedules on Construction Drawings.

J. Electrical Characteristics:
1. Refer to schedules on Construction Drawings.

2.3 HYDRONIC RADIANT HEATERS

A. Manufacturers:
1. Aero Tech
2. Air Tech
3. Sterling
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Ceiling Panels: Constructed of modular 6 inch wide aluminum extrusions with interlocking edges; manufactured and assembled to sizes and configurations indicated.

C. Pipe Coil: 6 inch module to incorporate extruded void into continuous 1/2 inch copper pipe is rolled and thermally bonded. Furnish return bends for two water connections to each panel.

D. Cross brace entire assembly with structural members and insulate with 1 inch thick fiberglass insulation. Configure panels within T-bar ceiling module and run wall to wall.

E. Heating Capacity: As scheduled.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. For recessed units, verify recess dimensions are correct size.

C. Verify wall construction is ready for installation.

3.2 INSTALLATION

A. Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.

B. Protection: Install finished cabinet units with protective covers during remainder of construction.

C. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

D. Cabinet Unit Heaters: Install at locations as indicated on Drawings. Coordinate to assure correct recess size for recessed units.

E. Hydronic Units: Install with shut-off valve on supply piping and lockshield balancing valve on return piping. Where not accessible, extend vent to exterior surface of cabinet for servicing. For cabinet unit heaters, fan coil units, and unit heaters, install float operated automatic air vents with stop valve. Refer to Section 23 21 13.

3.3 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

D. Install new filters.

END OF SECTION

SECTION 260400 - GENERAL CONDITIONS FOR ELECTRICAL TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This section applies to certain sections of Division 8 “Openings”, Division 11 “Equipment”, Division 12 “Furnishings”, Division 21 “Fire Protection”, Division 22 “Plumbing”, Division 23, "Mechanical,", Division 27 “Communications”, Division 28 “Electronic Safety and Security”, Division 33 “Utilities” and this section applies to all sections of Division 26, "Electrical" of this project specification unless specified otherwise in the individual sections.

C. The Drawings of other trades (Architectural, Structural, Civil, Plumbing, Mechanical, Food Service, Fire Protection, Communications, and Electronic Safety and Security) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.

D. The Drawings of equipment suppliers shall be examined for coordination and familiarity of work with Owner’s equipment suppliers.

1.2 DESCRIPTION

A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.

B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

C. It is the intent of this Section of the Specifications to establish a standard of quality and performance characteristics for basic materials and installation methods used in building electrical, communications and electronic safety and security systems.

1.3 INTENT

A. This contract is for all labor, materials and equipment required for installation. The system shall be complete and finished in all respects, tested and ready for operation. Work shall include calibration of equipment with factory settings. 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 necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if

not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.

C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.

D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

E. Wherever a particular piece of equipment, device or material is specifically indicated on the Drawings by model number, type, series or other means, that specification shall take precedence over equipment or materials specified herein. For example: If a particular switch is specified on the Drawings, its specification takes precedence over switch specified herein.

1.4 DEFINITIONS

A. Word “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Mechanical Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.

B. Word “install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.

C. Words “furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, all ready to be installed including where appropriate all necessary interim storage and protection.

D. Word “provide” shall mean furnish (or supply) and install as necessary.

E. Word “finished” refers to all rooms and areas scheduled to be painted in Room Finish Schedule on the drawings. All rooms and areas not covered in Schedule, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.

F. Words “approved equal” mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.

G. Word “wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system. Word “product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.

H. Substitutions: Requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the Contractor after award of the Contract are considered requests for "substitutions."

I. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

J. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

K. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.

L. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

M. Remove: The term “remove” means “to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”

N. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

O. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.5 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.

D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.6 SURVEYS AND MEASUREMENTS

A. Before submitting his Bid, the Contractors shall visit the site and become thoroughly familiar with all existing conditions under which his work will be installed. All new equipment and systems shall be fully operational under this Contract before the job is considered complete. The Contractors shall be held responsible for any assumptions he makes, any omissions or errors he makes as a result of his failure to become fully familiar with the existing conditions at the site and the Contract Documents.

B. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

1.7 CODES AND STANDARDS

A. Reference Standard Compliance
1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
2. Independent Testing Organization Certificate: In lieu of the label or listing, indicated above submit a certificate from an independent testing organization, competent to perform testing, and approved by the engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

B. The Following Codes and Standards listed below apply to all electrical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:
State of Connecticut Department of Construction Services (DCS) and Office of School Facilities Division.
Connecticut State Building Code - Connecticut Supplement
Connecticut State Fire Safety Code – Connecticut Supplement
The International Building Code
The International Mechanical Code
The International Plumbing Code
The BOCA National Code Supplement
The National Electrical Code
NFPA 101 Life Safety Code
The International Energy Conservation Code
ASHRAE 90.1 and International Energy Conservation Code

C. The following Standards shall be used where referenced by the following abbreviations:

AIA	American Institute of Architects
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
IEEE	Institute of Electrical and Electronics Engineers
NBS	National Bureau of Standards
NEMA	National Electrical Manufacturers Association
NETA	International Electrical Testing Association

NFPA	National Fire Protection Association
NSC	National Safety Council
OSHA	Occupational Safety and Health Administration
UL	Underwriters' Laboratories

D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.

E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.8 PERMITS AND FEES

A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.9 EQUIPMENT SUBSTITUTIONS

A. In these Contract Documents, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. These describe the basis of design and approved equivalents. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation without consideration of any or all costs associated but not limited to (structural, mechanical, or electrical feeder, breaker, or transformer requirements). The Contractor acknowledges that not all requirements are shown for either alternate acceptable manufacturers listed or those alternates requiring a request for substitution and it is their responsibility to coordinate all requirements necessary to accommodate any change from the basis of design listed or scheduled. The Contractor is required to submit any and all costs (including costs associated or required by all trades) along with performance differences as part of their request for substitution. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.

B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineers review.

C. Where two or more names are given as approved manufacturers of equivalents, the Contractor must use the specified item or one of the named equivalents which still must meet all of the performance characteristics of the basis of design make and model. Where one name only is used and is followed by the words "or approved equal", the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.

D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the equipment or materials as hereinafter specified, they are required to submit a request for substitution in writing. The Contractor shall state in their request whether it is a substitution

or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer's equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.

E. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Engineers/Architects of Record at the expense of the Contractor and at no additional cost to the Owner.

F. Where such accepted deviation resulting from using an approved equivalent or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, after acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the deviation.

G. Equipment, material or devices submitted for review as an "equivalent" shall meet the following requirements:
   1. The equivalent shall have the same construction features such as, but not limited to:
      a. Material thickness, gauge, weight, density, etc.
      b. Welded, riveted, bolted, etc., construction.
      c. Finish, undercoating, corrosion protection.
      d. In the case of lighting fixtures, equivalent shall also meet the form, shape, and function in the opinion of the Architect and Engineer.
   2. The equivalent shall perform with the same or better operating efficiency.
   3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
   4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.

H. Equipment, material or devices submitted for review as a "substitution" shall meet the following requirements:
   1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the Engineer, the Engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
   2. Submit three (3) copies of each request for substitution for consideration.
   3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
      a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
      b. Samples, where applicable or requested.
      c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
      d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and

separate Contractors that will become necessary to accommodate the proposed substitution.

e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.

f. Cost information, including a proposal of the net change, if any in the Contract Sum.

g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.

h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.

i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.

1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.

2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.

3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.10 SUBMITTAL PROCEDURES

A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmitals.
   1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
   2. If an intermediate submittal is necessary, process the same as the initial submittal.
   3. Allow two weeks for reprocessing each submittal.
   4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.

D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
   1. Include the following information on the label for processing and recording action taken.
      a. Project name.
      b. Date.
      c. Name and address of Engineer.
      d. Name and address of Contractor.
      e. Name and address of subcontractor.
      f. Name and address of supplier.
      g. Name of manufacturer.
      h. Number and title of appropriate Specification Section.
      i. Drawing number and detail references, as appropriate.

E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

F. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.

G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

1.11 SHOP DRAWINGS

A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated

in the Electrical Contract. Refer to the General Conditions and Supplementary General Conditions for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.

C. Provide shop drawings for all devices specified under equipment specifications for all systems including fire alarm, switchgear, clock, lighting, etc., or where called for elsewhere in the Specifications. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures) of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

D. Submittals shall be marked with the trade involved, i.e., Electrical, HVAC, Fire Protection, etc. when the submittal could involve more than one trade.

E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.

F. Failure to submit shop drawings in ample time for review shall not entitle the Contractor to an extension of Contract time. No claim for extension by reason of such default will be allowed, nor shall the Contractor be entitled to purchase, furnish and/or install equipment which has not been reviewed by the Engineer.

G. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.

H. Acceptance rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.

I. Acceptance of shop drawings shall not apply to quantity nor relieve Contractor of his responsibility to comply with intent of Drawings and Specifications.

J. Acceptance of shop drawings is final and no further changes will be allowed without the written consent of the Engineer.

K. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.

L. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.

M. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

1.12 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 1 Section "PROJECT COORDINATION," to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
   1. Indicate the proposed locations of light fixtures, swichboards, panelboards, lighting inverters, conduits, cabinets, etc. Include the following:
   2. Clearances for installing and maintaining insulation.
   3. Clearances for servicing and maintaining equipment, including NEC requirements and space for equipment disassembly required for periodic maintenance.
   4. Equipment connections and support details.
   5. Exterior wall and foundation penetrations.
   6. Fire-rated wall and floor penetrations.
   7. Sizes and locations of required concrete pads and bases.

B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

1.13 COORDINATION WITH OTHER DIVISIONS

A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.

B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, heating, condenser, chilled water piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.

C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.

D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

E. If so directed in other Sections, the Contractor indicated shall prepare composite working drawings and sections clearly showing how the work is to be installed in relation to the work of other trades, at no extra charge to the Owner.

1.14 WORKMANSHIP

A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, journeymen, electricians, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

E. All labor for installation of electrical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.15 SHUTDOWNS

A. When installation of a new system requires the temporary shutdown of an operating system, the connection of the new system shall be performed at such time as designated by the Owner.

B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.

C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.16 TEMPORARY UTILITIES

A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload

facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.

C. First Aid Supplies: Comply with governing regulations.

D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.

E. Provide temporary lighting in all areas, throughout construction activities.
1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.
2. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.
   a. Except where overhead service must be used, install electric power service underground.
   b. Power Distribution System: Install wiring overhead, and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 Volts, AC 20 ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.
3. Temporary Telephones: Provide temporary telephone service for all personnel engaged in construction activities, throughout the construction period.

F. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

G. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when 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 the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.17 PROJECT PHASING

A. Work under each Section shall include all necessary temporary connections, equipment, conduit, wiring, fire alarm equipment and testing, security equipment and testing, communications equipment and testing, lighting and emergency lighting, fire stopping, connection of necessary mechanical equipment, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All systems that pass-thru an area of the building shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required to maintain systems operational or to accommodate the construction phasing of the project.

1.18 PROTECTION OF MATERIALS AND EQUIPMENT

A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.

B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.

D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.19 ADJUSTING AND TESTING

A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.

B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct the personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing that the equipment was installed according to manufacturers' recommendations and is operating as intended by the manufacturer.

1.20 CLEANING

A. The Contractor shall thoroughly clean all equipment of all foreign substances, oils, dust, dirt, etc., inside and out before final acceptance by the Engineer.

B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

C. During the course of construction, all conduits shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.

D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work.

E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
   1. Remove labels that are not permanent labels.
   2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
   3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces and panelboard interiors.
   4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean light fixtures and lamps.

F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.

G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.21 OPERATING AND MAINTENANCE

A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner’s representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.

C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.

D. An authorized manufacturer’s representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: emergency generator, fire alarm system, nurse call system, paging systems, etc. These letters will be bound into the operating and maintenance books.

E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

F. Demonstration shall be recorded on CD/DVD disc with two (2) discs turned over to the Owner.

1.22 OPERATING AND MAINTENANCE MANUALS

A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance

data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty, 3-ring, vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder.

B. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Emergency instructions.
6. Spare parts list.
7. Copies of warranties.
8. Wiring diagrams.
9. Recommended "turn around" cycles.
10. Inspection procedures.
11. Shop Drawings and Product Data.
12. Equipment start-up reports.

C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.

D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.23 ACCEPTANCES

A. The equipment, materials, workmanship, design and arrangement of all work installed under the Electrical Sections shall be subject to the review of the Engineer.

B. Within 30 days after the awarding of a Contract, the Electrical Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Electrical Sections. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.

C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of the awarding of the Contract. In such instances, deviations may be made pending acceptance by the Engineer or the Owner’s representative.

D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Electrical Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment

characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.

E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.

F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.24 RECORD DRAWINGS

A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
1. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
2. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
3. Note related Change Order numbers where applicable.
4. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
5. Final record documents shall be prepared in the latest Revit version and floppy disks or CD ROM of all drawings and a clean set of reproducible mylar sepias shall be turned over to the Owner at the completion of the work.

1.25 WARRANTIES AND BONDS

A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
1. General close-out requirements included in Section "Project Close-out."
2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted are included in the individual Sections of Divisions 2 through 28.
3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.26 WARRANTY REQUIREMENTS

A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
   1. Refer to individual Sections of Divisions 2 through 33 for specific content requirements, and particular requirements for submittal of special warranties.

J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
   1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the 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 the installer.
   2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
   3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.27 GUARANTEES

A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineers satisfaction.

B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided

1.28 PROJECT CLOSE-OUT

A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.

B. Deliver tools, spare parts, extra stock, and similar items.

C. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

D. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

E. Inspection Procedures: On receipt of a request for inspection, the Engineer will either proceed with inspection or advise the Contractor of unfilled requirements. The Engineer will prepare the Certificate of Substantial Completion following inspection, or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
   1. The Engineer will repeat inspection when requested and assured that the Work has been substantially completed.
   2. Results of the completed inspection will form the basis of requirements for final acceptance.

END OF SECTION

CADD File Release Form

DELIVERY OF CADD FILES FOR: _____
Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ _____
Client's Signature Date

_____
Company - Title

_____ _____
Architects' Signature Date

_____
Firm - Title

_____ _____
Owner's Signature Date

_____
Company - Title

SECTION 260503 - EQUIPMENT WIRING CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes electrical connections to equipment.

B. Related Sections:
1. Section 26 05 19 – Building Wire and Cable.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 27 26 – Wiring Devices
4. Section 26 29 13 – Enclosed Controllers

C. Related Requirements:
1. This section applies to certain sections of Division 8 “Door Hardware”, Division 11 “Equipment”, Division 12 “Furnishings”, Division 21 “Fire Protection”, Division 22 “Plumbing”, Division 23, "Mechanical,", Division 27 “Communications”, and Division 28 “Electronic Safety and Security” of this project specification unless specified otherwise in the individual sections.
2. The Drawings of other trades (Architectural, Plumbing, Mechanical, Food Service, Fire Protection, Communications, and Electronic Safety and Security) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Submittal procedures.

B. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.5 COORDINATION

A. Section 01 30 00 - Administrative Requirements Coordination and project conditions.

B. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

C. Determine connection locations and requirements, including requirements for control stations, safety devices, control wiring, and accessories for equipment furnished under other sections.

D. Sequence rough-in of electrical connections to coordinate with installation of equipment. Do not proceed with rough-in without coordination of requirements for equipment furnished under other sections.

E. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.1 CORD AND PLUGS

A. Manufacturers:
1. Hubbell.
2. Leviton.
3. Bryant.
4. Substitutions: Section 01 60 00 - Product Requirements

B. Attachment Plug Construction: Conform to NEMA WD 1.

C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.

D. Cord Construction: Type SO, SJO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements Coordination and project conditions.

B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.2 INSTALLATION

A. Make electrical connections.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations, including pool equipment rooms.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Install receptacle outlet to accommodate connection with attachment plug.

E. Install cord and cap for field-supplied attachment plug.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

J. Install conduit and wiring for interconnection of motorized door operator control stations, safety devices and accessories to complete equipment wiring requirements.

K. Install conduit and wiring for interconnection of control stations, safety devices and accessories to complete equipment wiring requirements.

L. Install conduit and wiring for interconnection of lighting and switches furnished with equipment.

M. Install conduit and wiring for interconnection of alarm initiating devices, control panels and annuciators furnished with equipment.

N. Install conduit and wiring for interconnection of power supplies furnished by other divisions.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements Testing, adjusting, and balancing.

B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION

SECTION 260519 - BUILDING WIRE AND CABLE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes building wire and cable; service entrance cable; metal clad cable; and rated feeder wiring and wiring connectors and connections.

B. Related Sections:
1. Section 07 84 13 – Penetration Firestopping.
2. Section 26 05 53 - Identification for Electrical Systems: Product requirements for wire identification.
3. Section 26 09 23 – Lighting Control Devices.
4. Section 26 27 26 – Wiring Devices.
5. Section 26 51 00 – Interior Lighting.
6. Section 26 52 00 – Emergency Lighting.
7. Section 26 55 62 – Theatrical Lighting and Controls.
8. Section 26 56 00 – Exterior Lighting.

1.2 REFERENCES

A. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.
2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

1.3 SYSTEM DESCRIPTION

A. Product Requirements: Provide products as follows:

1. Solid conductor for feeders and branch circuits 10 AWG and smaller.
2. Stranded conductors for control circuits.
3. Conductor not smaller than 12 AWG for power and lighting circuits.
4. Conductor not smaller than 14 AWG for control circuits.
5. Increase wire size in branch circuits to limit voltage drop to a maximum of 3 percent.

B. Wiring Methods: Provide the following wiring methods:
1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN insulation, in raceway, or metal clad MC cable for final connections to recessed lighting fixtures only.
4. Wet or Damp Interior Locations: Use only building wire, Type THHN/THWN insulation, in rigid conduit.

5. Wet or Damp corrosive environments (Aquaculture Equipment Rooms): Use only building wire, Type THHN/THWN insulation, in Schedule 40 PVC conduit.
6. Exterior Locations: Use only building wire, Type XHHW insulation, in schedule 40/80 PVC conduit for lighting circuits.
7. Underground Locations: Use only building wire, Type XHHW insulation in conduit.
8. Rated Feeders: Use Type M.I. Cable.

1.4 DESIGN REQUIREMENTS

A. Conductor sizes are based on copper.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures Requirements for submittals.

B. Product Data: Submit for building wire and each cable assembly type.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of components and circuits.

1.7 QUALITY ASSURANCE

A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.

B. Perform Work in accordance with the current issue of the State of Connecticut Building code.

C. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.9 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on Drawings.

1.10 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

PART 2 PRODUCTS

2.1 BUILDING WIRE

A. Manufacturers:
1. American Insulated Wire Corporation.
2. General Cable Co.
3. SouthWire.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Single conductor insulated wire.

C. Conductor: Copper.

D. Insulation: Type THHN/THWN for all branch circuits and feeders except rated emergency feeders (or as otherwise described above). Type XHHW for feeders in ductbanks.

2.2 METAL CLAD CABLE (MC)

A. Manufacturers:
1. AFC Cable Systems, Inc.
2. General Cable Co.
3. SouthWire.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Conductor: Copper.

C. Use: Use only for final connections to recessed lighting fixtures, or to fish within drywall partitions. (all other circuits shall be in EMT or other raceway as indicated within Section 26 05 33).

2.3 MINERAL INSULATED CABLE (TYPE M.I.)

A. Rating: M.I. cables shall be U.L. Listed and rated for 2 hours fire resistivity.

B. Handling: Cables shall be installed, stored, prepared, and terminated per manufacturer's requirements.

C. Splices: Splices shall be performed by manufacturer's representative or certified personnel trained in proper termination techniques.

D. Supports: Provide cable supports at 3'-0" max. horizontally, 6'-0" max. vertically. Anchors shall be steel.

E. Configuration: Single conductors run together to form multi-phase feeders shall be installed in a tri-foil configuration. All sheaths shall maintain contact with each other until entering into termination enclosure. Provide stainless steel straps to form bundles. Straps shall be installed at 3'-0" max. horizontal and vertical runs.

F. Sheath material: Seamless soft-drawn copper.

G. Lugs: Cables shall terminate on approved lugs.

H. Manufacturers: Pyrotenax/Pentair.

2.4 WIRING CONNECTORS

A. Split Bolt Connectors:
1. Ilsco.
2. Thomas Betts.
3. Burndy.
4. Buchanan.
5. Substitutions: Substitutions: Section 01 60 00 - Product Requirements.

B. Solderless Pressure Connectors:
1. Ilsco.
2. Thomas Betts.
3. Burndy.
4. Buchanan.
5. Substitutions: Substitutions: Section 01 60 00 - Product Requirements.

C. Spring Wire Connectors:
1. Ilsco.
2. Thomas Betts.
3. Burndy.
4. Buchanan.
5. Substitutions: Substitutions: Section 01 60 00 - Product Requirements.

D. Compression Connectors:
1. Ilsco.
2. Thomas Betts.
3. Burndy.
4. Buchanan.
5. Substitutions: Substitutions: Section 01 60 00 - Product Requirements.

2.5 TERMINATIONS

A. Terminal lugs for Wires 6 AWG and Smaller: Solderless, compression type copper.

B. Lugs for Wires 4 AWG and Larger: Color keyed, compression type copper, with insulating sealing collars.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify interior of building has been protected from weather.

C. Verify mechanical work likely to damage wire and cable has been completed.

D. Verify raceway installation is complete and supported.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

A. Type MC cable may be used for drops within existing drywall partitions and final connections to normal power lighting fixtures. Provide EMT and building wire for all other circuits.

B. Route wire and cable to meet Project conditions.

C. Neatly train and lace wiring inside boxes, equipment, and panelboards.

D. Identify and color code wire and cable under provisions of this section. Identify each conductor with its circuit number or other designation indicated.

E. Special Techniques--Building Wire in Raceway:
1. Pull conductors into raceway at same time.
2. Install building wire 4 AWG and larger with pulling equipment.
3. Use of pulling compounds not allowed for pulling of wire used for isolated power systems.

F. Special Techniques - Cable:
1. Protect exposed cable from damage.
2. Support cables above accessible ceiling, using spring metal clips or cable ties to support cables from structure. Do not rest cable on ceiling panels.
3. Use suitable cable fittings and connectors.

G. Special Techniques - Wiring Connections:
1. Clean conductor surfaces before installing lugs and connectors.
2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

H. Install stranded conductors for control circuits 14 AWG and smaller. Install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.

I. Install terminal lugs on ends of 600 volt wires unless terminal lugs are furnished on connected device, such as circuit breakers.

J. Size lugs in accordance with manufacturer’s recommendations for terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.

K. For terminal lugs fastened together such as on motors, transformers and other apparatus, or when spaced between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength 2-1/2 times normal potential of circuit.

L. Mineral Insulated Cable Installation:
1. The wiring and cable shall be installed according to the manufacturers' recommendations, the instructions in the installation and specifications manual and the requirements of the UL Fire Resistance Directory listing.
2. Provide brass glands, termination kits and fittings from the same manufacturer as the cable. Provide brass plates for entrance fittings to ferrous enclosures per the manufacturer's recommendations.

3.4 WIRE COLOR

A. General:
1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
a. Black and red for single phase circuits at 120/240 volts.
b. Black, red, and blue for circuits at 120/208 volts single or three phase.
c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes.

B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.

C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.

D. Feeder Circuit Conductors: Uniquely color code each phase as indicated above.

E. Ground Conductors:
1. For 6 AWG and smaller: Green.
2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.5 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rod electrodes.
2. Wire.
3. Mechanical connectors.
4. Exothermic connections.
5. Building Ground Ring.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:
1. Metal underground water pipe.
2. Metal building frame.
3. Metal underground gas piping system.
4. Rod electrode.

1.4 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 10 ohms maximum.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.7 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

B. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum3 years experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.10 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

A. Manufacturers:
   1. Copperweld, Inc.
   2. Erico, Inc.
   3. O-Z Gedney Co.
   4. Thomas & Betts, Electrical
   5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description:
   1. Material: Copper-clad steel.
   2. Diameter: 3/4 inch.
   3. Length: 10 feet.

C. Connector: Connector for exothermic welded connection.

2.2 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: 4 AWG.

C. Grounding Electrode Conductor: Copper conductor insulated.

D. Bonding Conductor: Copper conductor bare or insulated.

2.3 MECHANICAL CONNECTORS

A. Manufacturers:
1. Copperweld, Inc.
2. Erico, Inc.
3. ILSCO Corporation
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical.
6. Substitutions: Section 01 60 00 - Product Requirements

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.4 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. Cadweld, Erico, Inc.
2. Copperweld, Inc.
3. ILSCO Corporation.
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical.
6. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.3 INSTALLATION

A. Install in accordance with IEEE 142.

B. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.

C. Install grounding and bonding conductors concealed from view.

D. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

E. Install continuous grounding using underground cold water system, driven rods and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.

F. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

G. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

H. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.

I. Permanently attach equipment and grounding conductors prior to energizing equipment.

J. Connections to Lightning Protection System: Bond grounding conductors, including grounding-conductor conduits, to lightning protection down conductors or lightning protection grounding conductors in compliance with NFPA 780.

K. Common Ground Bonding with Lightning Protection System: Bond electric power system, grounding electrode system directly to lightning protection system earth connection at closest point to electric service grounding electrode. Use bonding conductor sized the same as system grounding conductor and install in conduit.

3.4 COUNTERPOISE

A. Provide a ground ring conductor (counterpoise) extending around perimeter of the building. Bury counterpoise not less than 30 inches below grade and 5 feet from the building foundation. Use #4/0 conductor and for taps to building steel. Fill trench with ground enhancement material a minimum of 1” above and below the conductor.

B. Ground the steel frame of the building with a ground rod at every corner column and at every other exterior column. Locate ground rods at counterpoise trench and attach to the counterpoise conductor. The top of the ground rod shall be not less than 24” below grade.

3.5 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.

C. Perform ground resistance testing in accordance with IEEE 142.

D. Perform leakage current tests in accordance with NFPA 99.

E. Perform continuity testing in accordance with IEEE 142.

F. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

G. Results of the above shall be documented in writing and provided within the O&M manuals and to the CX agent as part of the closeout.

END OF SECTION

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary".

1.2 SUMMARY

A. Section Includes:

1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Equipment bases and supports.

B. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Division 07 Section – Penetration Firestopping.

1.3 REFERENCES

A. ASTM International:

1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

B. FM Global:

1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data:

1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.

E. Manufacturer's Installation Instructions:

1. Hangers and Supports: Submit special procedures and assembly of components.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum three years experience, approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:

1. Allied Tube & Conduit Corp.
2. O-Z Gedney Co.
3. Thomas and Betts
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:

1. Allied Tube & Conduit Corp.
2. B-Line Systems.
3. Unistrut Corp.
4. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

A. Manufacturers:

1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Unistrut Corp.
4. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

A. Sleeves for conduit, raceway, cable tray, busway, or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for conduit, raceway, cable tray, busway, or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for conduit, raceway, cable tray, busway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. PSI Link-Seal.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and

pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

C. Use: Provide for all penetrations through foundation walls.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Obtain permission from Architect before using powder-actuated anchors.

C. Obtain permission from Architect before drilling or cutting structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:

1. Concrete Structural Elements: Provide precast inserts and expansion anchors.
2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:

1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every floor.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.

3.5 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 6 inches above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

3.6 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

3.7 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

3.8 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:
1. Section 07 84 13 – Penetration Firestopping
2. Section 26 05 03 - Equipment Wiring Connections.
3. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
4. Section 26 05 29 - Hangers and Supports for Electrical Systems.
5. Section 26 05 53 - Identification for Electrical Systems.
6. Section 26 27 26 - Wiring Devices.
7. Section 26 51 00 – Interior Lighting.
8. Section 26 52 00 – Emergency Lighting.
9. Section 26 56 00 – Exterior Lighting.
10. Section 28 31 00 – Fire Detection and Alarm.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).

B. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground more than 5 feet outside Foundation Wall: Provide PVC conduit.

C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit.

D. In or Under Slab on Grade: Provide PVC conduit with rigid steel conduit sweeps.

E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal or nonmetallic outlet, pull, and junction boxes.

F. In Slab Above Grade: Provide rigid steel conduit. Provide cast boxes.

G. Wet and Damp Locations: Provide rigid steel conduit. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.

H. Wet or Damp corrosive environments (Aquaculture Program Rooms): Use only building wire, Type THHN/THWN insulation, in Schedule 40 PVC conduit. Provide non-metallic WP boxes.

I. Concealed Dry Locations: Provide EMT conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

J. Dry Finished Locations: Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

K. Exposed Dry Finished Locations: Provide surface metal raceway and fittings. Unless specified on drawings, requires design team approval for use of surface metal raceway in finished locations.

1.4 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit for the following:
1. Flexible metal conduit.
2. Liquidtight flexible metal conduit.
3. Nonmetallic conduit.
4. EMT.
5. Raceway fittings.
6. Conduit bodies.
7. Surface raceway.
8. Wireway.
9. Pull and junction boxes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents:
1. Record actual routing of conduits larger than 2 inch.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.8 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.

C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Rigid Steel Conduit: ANSI C80.1.

C. Rigid Aluminum Conduit: ANSI C80.5.

D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fittings: NEMA FB 1.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Anamet Electrical.
3. Allied Tube and Conduit.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fittings: NEMA FB 1.

2.4 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel, set screw type.

2.5 NONMETALLIC CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Allied Tube and Conduit.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA TC 2; Schedule 40/80 PVC.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.6 SURFACE METAL RACEWAY

A. Manufacturers:
1. Hubbell Wiring Devices.
2. Thomas & Betts Corp.
3. The Wiremold Co.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. Finish: Architect to select from manufacturers standard color palette.

D. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.7 WIREWAY

A. Manufacturers:
1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Hoffman.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: General purpose type wireway.

C. Knockouts: Manufacturer's standard.

D. Cover: Screw cover.

E. Finish: Rust inhibiting primer coating with gray enamel finish.

2.8 OUTLET BOXES

A. Manufacturers:
1. Erico Products.
2. Raco.
3. Thomas & Betts Corp.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Nonmetallic Outlet Boxes: NEMA OS 2.

D. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer.

E. Wall Plates for Finished Areas: As specified in Section 26 27 26.

F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

G. Provide boxes listed for “EXTRA DUTY” for exterior receptacle locations.

2.9 PULL AND JUNCTION BOXES

A. Manufacturers:
1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Surface Mounted Cast Metal Box: NEMA 250; flat-flanged, surface mounted junction box:
1. Material: Cast aluminum.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 26 05 26.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.

C. Identify raceway and boxes in accordance with Section 26 05 53.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.3 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in Section 26 05 29.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit in and under slab from point-to-point.

K. Maintain clearance between raceway and piping for maintenance purposes.

L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

M. Cut conduit square using saw or pipe cutter; de-burr cut ends.

N. Bring conduit to shoulder of fittings; fasten securely.

O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

P. Install conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.

R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

S. Seal all raceway entering a building from the exterior with sealant identified for use with the cable insulation, shield or other cabling components.

T. Install fittings to accommodate expansion and deflection where raceway crosses expansion joints.

U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

X. Close ends and unused openings in wireway.

3.4 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.

B. Adjust box location prior to rough-in to accommodate intended purpose.

C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

I. Install stamped steel bridges to fasten flush mounting outlet box between studs.

J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

K. Install adjustable steel channel fasteners for hung ceiling outlet box.

L. Do not fasten boxes to ceiling support wires or other piping systems.

M. Support boxes independently of conduit.

N. Install gang box where more than one device is mounted together. Do not use sectional box.

O. Install gang box with plaster ring for single device outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Section 07 84 13.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.

C. Locate outlet boxes to allow luminaires positioned as indicated on reflected ceiling plan.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.6 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.7 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 260534 - FLOOR BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes floor boxes; floor box service fittings; poke-through fittings; and access floor boxes.

B. Related Sections:
1. Section 07 84 13 –Penetration Firestopping.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 27 26 - Wiring Devices: Receptacles for installation in floor boxes.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures : Submittal procedures.

B. Product Data: Submit catalog data for floor boxes service fittings.

C. Samples: Submit two of each service fitting illustrating size, material, configuration, and finish.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of each floor box and poke-through fitting.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.6 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 FLOOR BOXES

A. Manufacturers:
1. Hubbell.
2. Walker.
3. Leviton.

4. Wiremold/Legrand.
5. Substitutions: Section 01 60 00 – Product Requirements.

B. Floor Boxes: NEMA OS 1.

C. Adjustability: Fully adjustable.

D. Material: Cast metal.

E. Shape: Rectangular.

2.2 FLUSH-COVER-TYPE CONVENIENCE RECEPTACLE SERVICE FITTING

A. Manufacturers:
1. Hubbell.
2. Walker.
3. Leviton.
4. Wiremold/Legrand.
5. Substitutions: Section 01 60 00 – Product Requirements.

B. Material: Brass.

C. Configuration: Duplex flap opening.

2.3 FLUSH-COVER-TYPE COMMUNICATION OUTLET

A. Manufacturers:
1. Hubbell.
2. Walker.
3. Leviton.
4. Wiremold/Legrand.
5. Substitutions: Section 01 60 00 – Product Requirements.

B. Material: Brass.

C. Configuration: Flap opening.

2.4 FLUSH-COVER-TYPE COMBINATION FITTING

A. Manufacturers:
1. Hubbell.
2. Walker.
3. Leviton.
4. Wiremold/Legrand.
5. Substitutions: Section 01 60 00 – Product Requirements.

B. Material: Brass.

C. Configuration: Flap openings.

D. For use in stage, lecture hall, gymnasium, fitness center and single use instructor’s stations only.

2.5 MULTI-SERVICE FLOOR BOX

A. Manufacturers:
1. Hubbell.
2. Walker.
3. Leviton.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Material: Cast-iron suitable for use on grade.

C. Configuration: Fully adjustable with four independent wiring compartments that allow capacity for up to four duplex outlets or communications devices. Box shall permit tunneling from adjacent or opposite compartments. Box shall provide a minimum of four 1” conduit hubs and four 1 1/4” conduit hubs.

D. Activation Cover: Die-cast flanged cover with brushed aluminum finish.

E. Accessories: Device mounting plates, faceplates and bezels for duplex receptacle and communications devices.

F. For use conference rooms and library.

2.6 HIGH CAPACITY MULTI-SERVICE FLOOR BOX

A. Manufacturers:
1. Hubbell.
2. Wiremold/Legrand.
3. Leviton.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Material: Concrete-tight stamped steel with fusion-bonded epoxy coating suitable for use on grade.

C. Configuration: Fully adjustable with eleven gang capacity, including (1) six gang compartment, (1) three gang compartment, and (2) one gang compartment. Box shall provide a minimum of: (3) concentric 1 1/4" & 2” conduit hubs to and (2) concentric 1 1/4” & 1” conduit hubs to the six gang compartment; (2) concentric 1 1/4" & 2” conduit hubs to and (1) concentric 1 1/4” & 1” conduit hubs to the three gang compartment; and (3) concentric 1 1/4" & 2” conduit hubs to and (1) concentric 3/4” & 1” conduit hub to each one gang compartment.

D. Activation Cover: Cast aluminum flush cover.

E. Accessories: Device mounting plates, faceplates and bezels for duplex receptacle and communications devices.

F. For use as indicated on drawings.

2.7 FOOD SERVICE AREA BOXES

A. Manufacturers:
1. Hubbell.
2. Wiremold/Legrand.

3. Leviton.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Material: Stainless Steel finishes on exposed surfaces.

C. Configuration: Match utilization equipment requirements. Provide pedestal type fitting with matching floor box and required accessories in locations required.

2.8 POKE-THROUGH FITTINGS

A. Manufacturers:
1. Hubbell.
2. Leviton.
3. Wiremold/Legrand.
4. Substitutions: Section 01 60 00 – Product Requirements.

B. Product Description: Combination power/telecommunications assembly comprising service fittings, poke-through component, fire stops and smoke barriers, and junction box for conduit termination..

C. Fire Rating: 3 hours.

D. Service Fitting Type: Flush.

E. Housing: cast aluminum.

F. Device Plate: Brass.

G. Configuration: Varies, provide with flush cover assemblies for receptacles, combination power/telecommunications or furniture feeds as indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Where use for a device is not specified, consult with Architect and Engineer prior to rough-in.

C. Verify locations of floor boxes and outlets in work areas prior to rough-in.

D. Verify openings in access floor are in proper locations.

3.2 INSTALLATION

A. Boxes and fittings are indicated on Drawings in approximate locations unless dimensioned. Adjust box location to accommodate intended purpose.

B. Floor Box Requirements: Use cast floor boxes or stamped steel with fusion epoxy coating for installations in slab on grade; formed steel boxes are acceptable for other installations.

C. Set floor boxes level.

D. Install boxes and fittings to preserve fire resistance rating of slabs and other elements, using materials and methods specified in Section 07 84 00.

E. Install protective rings on active flush cover service fittings.

F. Confirm quantity of devices and cables intended for each box, and cable types before purchasing or setting devices.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust floor box flush with finish flooring material.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

END OF SECTION

SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes cable tray.

B. Related Sections:
1. Section 07 84 13 – Penetration Firestopping.
2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
3. Section 26 05 29 - Hangers and Supports for Electrical Systems

1.2 REFERENCES

A. ASTM International:
1. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. National Electrical Manufacturers Association:
1. NEMA FG 1 - Nonmetallic Cable Tray Systems.
2. NEMA VE 1 - Metal Cable Tray Systems.
3. NEMA VE 2 - Metal Cable Tray Installation Guidelines.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.

C. Product Data: Submit fittings and accessories.

D. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience, and with service facilities within 100 miles of Project.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

PART 2 PRODUCTS

2.1 METAL LADDER-TYPE CABLE TRAY

A. Manufacturers:
1. B-Line Systems.
2. Cope.
3. Thomas and Betts.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA VE 1, Class 20C ladder type tray.

C. Material: Aluminum.

D. Finish: Galvanized to ASTM A123/A123M; galvanize after fabrication..

E. Inside Width: 18 inches or as indicated on Drawings.

F. Inside Depth: 5 inches or indicated on Drawings.

G. Straight Section Rung Spacing: 9 inches on center.

H. Inside Radius of Fittings: 24 inches.

I. Furnish manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

2.2 WARNING SIGNS

A. Engraved Nameplates: 1/2 inch black letters on yellow laminated plastic nameplate, engraved with: WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

PART 3 EXECUTION

3.1 INSTALLATION

A. Install metal cable tray in accordance with NEMA VE 2.

B. Support trays and fasten to structure and finishes in accordance with Section 26 05 29. Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of 10 ft maximum.

C. Install expansion connectors where recommended by manufacturer or as indicated on Drawings.

D. Install firestopping in accordance with Section 07 84 00 to sustain ratings when passing cable tray through fire-rated elements.

E. Ground and bond metal cable tray in accordance with Section 26 05 26.
   1. Provide continuity between tray components.
   2. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
   3. Install 2 AWG bare copper equipment grounding conductor through entire length of tray; bond to each component.
   4. Make connections to tray using mechanical, compression or exothermic connectors.

F. Install warning signs at 50 feet centers along cable tray, located to be visible.

END OF SECTION

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.
5. Stencils.
6. Underground Warning Tape.
7. Lockout Devices.

B. Related Sections:
1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures Submittal procedures.

B. Product Data:
1. Submit manufacturer’s catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept identification products on site in original containers. Inspect for damage.

C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Install nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color. White letters on Red background for emergency equipment.

B. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.

C. Letter Size:
1. 1/8 inch high letters for identifying individual equipment and loads.
2. 1/4 inch high letters for identifying grouped equipment and loads.

D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color. White letters on Red background for emergency equipment.

2.3 WIRE MARKERS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries

2.4 CONDUIT AND RACEWAY MARKERS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries

B. Legend:
1. 208 Volt System: 208 VOLTS.
2. 480 Volt System: 480 VOLTS

3. Emergency Power Systems: Emergency (with voltage following “Emergency”)
4. Telephone System: Telephone
5. Voice/Data Systems: Voice/Data
6. Security System: Security
7. Audiovisual System: AV

2.5 UNDERGROUND WARNING TAPE

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements. Description: 4 inch wide plastic tape, detectable type, colored yellow with suitable warning legend describing buried electrical lines.

2.6 DEVICE IDENTIFICATION

A. Service Equipment:
1. Labeling:
a. Indicate the maximum available fault current at the equipment, including the date the fault current calculation was performed. Label shall include warning for “Arc Flash Hazard” and requirement for “PPE protection”.
b. Indicate Equipment designation.

B. Panelboards:
1. Labeling:
a. Indicate power supply origin (panelboard or transformer) of source feeding the panelboard.
b. Indicate Panelboard designation.

C. Roof Top HVAC Equipment Disconnects:
1. Labeling:
a. Indicate equipment name.
b. Indicate source panel and circuit number.

D. Receptacles:
1. Labeling:
a. Indicate source panel and circuit number at each cover plate.
b. Cover plates shall be labeled with information indicated above using a permanent label.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:
   1. Install nameplate parallel to equipment lines.
   2. Install nameplate for each interior electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
   3. Install nameplates for each interior control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
   4. Install nameplates for each exterior control panel and equipment enclosure to equipment front using corrosive-resistant fasteners or rivets.
   5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
   6. Install nameplates for the following:
      a. Switchboards.
      b. Panelboards.
      c. Transformers.
      d. Disconnects.
      e. Transfer Switches.
      f. Motor Starters.
      g. Control Panels.

C. Label Installation:
   1. Install label parallel to equipment lines.
   2. Install label for identification of individual control device stations.
   3. Install labels for permanent adhesion and seal with clear lacquer.

D. Wire Marker Installation:
   1. Install wire marker for each conductor at panelboard gutters, pull boxes and junction boxes.
   2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
   3. Install labels at data outlets identifying patch panel and port designation.

E. Underground Warning Tape Installation:
   1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes electrical connections to equipment.

B. Related Sections:
1. Section 26 05 19 – Building Wire and Cable.

1.2 SECTION INCLUDES

A. Performance requirements for overcurrent protective devices.

B. Short circuit study.

C. Coordination study and analysis.

1.3 RELATED REQUIREMENTS

A. Section 26 24 13 - Switchboards: Overcurrent protective devices in switchboards.

B. Section 26 24 16 - Panelboards: Overcurrent protective devices in panelboards.

1.4 REFERENCE STANDARDS

A. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001.

B. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.

C. NFPA 70 - National Electrical Code; 2011.

1.5 SUBMITTALS

A. See Section 01 31 00 - Project Management, Coordination and Commissioning: for submittal procedures.

B. Study Preparer's Qualifications.

C. Study Report: Submit protective device studies as specified, prior to submission of product data submittals or ordering or fabrication of protective devices.
1. Evaluation of product data submittals by Engineer will not commence until acceptable preliminary studies in sufficient detail to ensure that device selection will be adequate have been submitted.
2. Include stamp or seal and signature of preparing engineer.

D. Product Data: In addition to submittals specified elsewhere, submit manufacturer's time-current curves for all protective devices.

E. Field Engineer Qualifications.

F. Field Inspection Report: Show final adjusted settings of protective devices.

G. Certificates: Prior to final inspection, certify that field adjustable protective devices have been set in accordance with requirements of protective device analysis.

H. Project Record Documents: Revise protective device study as required to show as-built conditions.
1. Submit not less than 60 days prior to final inspection of electrical system.
2. Include hard copies in operation and maintenance data submittals.
3. Include all files prepared using software packages, on CD-ROM, with file name cross-references to specific pieces of equipment and systems.

1.6 PROTECTIVE DEVICE STUDY

A. Analyze the specific electrical and utilization equipment (according to NEC definition), the actual protective devices to be used, and the actual feeder lengths to be installed.
1. Scope of Studies: All new distribution wiring and equipment, from primary source to buses and branch circuit panelboards.
2. Primary Source, for Purposes of Studies: Utility company primary protective devices.
3. Study Methodology: Comply with requirements and recommendations of NFPA 70, IEEE 399, and IEEE 242.
4. Report: State the methodology and rationale employed in making each type of calculation; identify computer software package(s) used.

B. One-Line Diagrams: Prepare schematic drawing of electrical distribution system, with all electrical equipment and wiring to be protected by the protective devices; identify nodes on the diagrams for reference on report that includes:
1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at the main switchboard bus and all downstream devices containing protective devices.
2. Breaker and fuse ratings.
3. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
4. Identification of each bus, with voltage.
5. Conduit materials, feeder sizes, actual lengths, and X/R ratios.

C. Short Circuit Study: Calculate the fault impedance to determine available 3-phase short circuit and ground fault currents at each bus and piece of equipment during normal conditions, alternate operations, emergency power conditions, and other operations that could result in maximum fault conditions.
1. Show fault currents available at key points in the system down to a fault current of 7,000 A at 480 V and 208 V.
2. Include motor contributions in determining the momentary and interrupting ratings of the protective devices.
3. Primary Fault Level Assumptions: Obtain data from utility company.
4. Report: Include all pertinent data used in calculations and for each device include:
   a. Device identification.
   b. Operating voltage.
   c. Protective device.
   d. Device rating.

e. Calculated short circuit current, asymmetrical and symmetrical, and ground fault current.

D. Coordination Study: Perform an organized time-current analysis of each protective device in series from the individual device back to the primary source, under normal conditions, alternate operations, and emergency power conditions.
1. Graphically illustrate that adequate time separation exists between series devices, including upstream primary device.
2. Plot the specific time-current characteristics of each protective device on log-log paper.
3. Organize plots so that all upstream devices are clearly depicted on one sheet.
4. Also show the following on curve plot sheets:
   a. Device identification.
   b. Voltage and current transformer ratios for curves.
   c. 3-phase and 1-phase ANSI damage curves for each transformer.
   d. No-damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum short circuit cutoff point.
   h. Simple one-line diagram for the portion of the system that each curve plot illustrates.
   i. Software report for each curve plot, labeled for identification.

E. Analysis: Determine ratings and settings of protective devices to minimize damage caused by a fault and so that the protective device closest to the fault will open first.
1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
2. Identify any equipment that is underrated.
3. Identify specified protective devices will not achieve required protection or coordination but with minor changes can be made to do so; provide such modified devices at no additional cost and identify them on submittals as "revised in accordance with Protective Device Coordination Study"; minor changes include different trip sizes in the same frame, time curve characteristics of induction relays, CT ranges, etc.
4. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve a change to the contract sum.
5. In all cases where adequate protection or coordination cannot be achieved at no extra cost, provide a discussion of alternatives and logical compromises for best achievable coordination.

F. Protective Device Rating and Setting Chart: Summarize in tabular format the required characteristics for each protective device based on the analysis; include:
1. Device identification.
2. Relay CT ratios, tap, time dial, and instantaneous pickup.
3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
4. Fuse rating and type.
5. Ground fault pickup and time delay.
6. Input level and expected response time at two test points that are compatible with commonly available test equipment and the ratings of the protective device.
7. Highlight all devices that as furnished by Contractor will not achieve required protection.

1.7 QUALITY ASSURANCE

A. Study Preparer Qualifications: Electrical testing agency regularly engaged in short circuit and coordination studies, with at least 5 years experience in work of this type, and employing professional electrical engineer licensed in the State of **Connecticut** to perform the studies.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

C. Contractor Responsibility: Provide all project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, and actual circuit lengths.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.3 PROTECTIVE DEVICES

A. Provide protective devices of ratings and settings as required so that the protective device closest to the fault will open first.

B. In addition to requirements specified elsewhere, provide overcurrent protective devices having ratings and settings in accordance with results of this analysis.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

1. Proceed with coordination study only after relevant equipment submittals have been assembled.

3.2 FIELD QUALITY CONTROL

A. Provide the services of a qualified field engineer and necessary tools and equipment to test, calibrate, and adjust the installed protective devices to conform to requirements determined by the coordination analysis.

B. Adjust installed protective devices having adjustable settings to conform to requirements determined by the coordination analysis.

C. Submit report showing final adjusted settings of all protective devices.

D. Results of the above shall be documented in writing and provided within the O&M manuals and to the CX agent as part of the closeout.

END OF SECTION

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

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 includes commissioning process requirements for Electrical systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

A. Refer to Division 01 Section “General Commissioning Requirements” for the description of commissioning.

1.4 DEFINITIONS

A. Refer to Division 01 Section “General Commissioning Requirements” for definitions.

1.5 SUBMITTALS

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s role.

B. Refer to Division 01 Section “Submittals” for specific requirements. In addition, provide the following:

C. Certificates of readiness

D. Certificates of completion of installation, pre-start, and startup activities.

E. O&M manuals

F. Test reports

1.6 QUALITY ASSURANCE

A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.7 COORDINATION

A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the electrical contractor of Division 26 shall ultimately be responsible for all standard testing equipment for the electrical systems and controls systems in Division 26.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

A. With assistance from the installing contractors, the CxA will prepare Pre-Functional Checklists for all commissioned components, equipment, and systems

B. Red-lined Drawings: The contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings. The contracted party, as defined in the Contract Documents will create the as-built drawings.

C. Operation and Maintenance Data: Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems. The CxA will review the O&M literature once for conformance to project requirements. The CxA will receive a copy of the final approved O&M literature once corrections have been mad by the Contractor.

D. Demonstration and Training: Contractor will provide demonstration and training as required by the specifications. A complete training plan and schedule must be submitted by the Contractor to the CxA four weeks (4) prior to any training. A training agenda for each training session must be submitted to the CxA one (1) week prior the training session

3.2 CONTRACTOR'S RESPONSIBILITIES

A. Perform tests as required by Division 26.

B. Attend construction phase controls coordination meetings.

C. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CA.

D. Provide information requested by the CxA for final commissioning documentation.

E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.

F. Prepare preliminary schedule for Electrical system orientations and inspections, operation and maintenance manual submissions, training sessions, equipment start-up and task completion for owner. Distribute preliminary schedule to commissioning team members.

G. Update schedule as required throughout the construction period.

H. Assist the CxA in all verification and functional performance tests.

I. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the test period.

J. Gather operation and maintenance literature on all equipment, and assemble in binders as required by the specifications. Submit to CxA 45 days after submittal acceptance.

K. Coordinate with the CxA to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.

L. Notify the CxA a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.

M. Participate in, and schedule vendors and contractors to participate in the training sessions.

N. Provide written notification to the CM/GC and CxA that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.

O. The equipment supplier shall document the performance of his equipment.

P. Provide a complete set of red-lined drawings to the CxA prior to the start of Functional Performance Testing.

Q. Equipment Suppliers
1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
2. Assist in equipment testing per agreements with contractors.
3. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.

R. Refer to Division 01 Section “General Commissioning Requirements” for additional Contractor responsibilities.

3.3 CxA'S RESPONSIBILITIES

A. Refer to Division 01 Section “General Commissioning Requirements” for CxA’s Responsibilities.

3.4 TESTING PREPARATION

A. Certify in writing to the CxA that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify in writing to the CxA that Electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.5 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of Electrical testing shall include the entire Electrical installation, from the incoming power equipment throughout the distribution system. Testing shall include measuring, but not limited to resistance, voltage, and amperage of system(s) and devices.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the Electrical contractor and other contracted subcontractors, including the fire alarm Subcontractor shall prepare detailed testing plans, procedures, and checklists for Electrical systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.6 ELECTRICAL SYSTEM TESTING PROCEDURES

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 26 sections. Provide submittals, test data, inspector record, infrared camera and certifications to the CA.

B. Electrical Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 26 Sections "Instrumentation and Control" and "Sequence of Operations" Assist the CxA with preparation of testing plans.

C. Fire Detection and Alarm System Testing: Provide technicians, instrumentation, tools and equipment to test performance of designated systems and devices at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

D. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

Electrical Systems
Lighting control systems
Emergency generator and associated transfer panels
Fire alarm system interfaces with HVAC systems
Security Systems
Telecommunication Systems

3.7 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.8 APPROVAL

A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.9 DEFERRED TESTING

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.10 OPERATION AND MAINTENANCE MANUALS

A. The Operation and Maintenance Manuals shall conform to Contract Documents requirements as stated in Division 01.

B. Refer to Division 01 Section “General Commissioning Requirements” for the AE and CxA roles in the Operation and Maintenance Manual contribution, review and approval process.

3.11 TRAINING OF OWNER PERSONNEL

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to training.

END OF SECTION 26 08 00

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Contactors.
2. Switches.
3. Switch plates.
4. Occupancy sensors.
5. Photocells.
6. Photocell control unit.
7. Classroom dimming control systems.

B. Related Sections:
1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.
2. Section 26 05 19 – Building Wire and Cable.
3. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Product requirements for raceway and boxes for placement by this section.
4. Section 26 05 53 - Identification for Electrical Systems: Product requirements for electrical identification items for placement by this section.
5. Section 26 27 26 - Wiring Devices: Product requirements for wiring devices for placement by this section.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer’s standard product data for each system component.

C. Manufacturer's Installation Instructions: Submit for each system component.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record the following information:
1. Actual locations of components and record circuiting and switching arrangements.
2. Wiring diagrams reflecting field installed conditions with identified and numbered system components and devices.

C. Sustainable Design Closeout Documentation
1. Lighting Control System Manufacturer to provide Enhanced Start-up documentation that details the start-up procedure being performed including a process to follow, details on tests performed and an area that documents any test results.

D. Operation and Maintenance Data:
   1. Submit replacement parts numbers.
   2. Submit manufacturer's published installation instructions and operating instructions.
   3. Recommended renewal parts list.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept components on site in manufacturer's packaging. Inspect for damage.

C. Protect components by storing in manufacturer's containers indoor protected from weather.

1.6 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five year manufacturer warranty for components.

1.7 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.

B. Furnish six of each switch type.

C. Furnish six of each occupancy sensor type.

D. Furnish two of each photocell type.

PART 2 PRODUCTS

2.1 LIGHTING CONTACTORS

A. Manufacturers:
   1. Automatic Switch Co.
   2. Cutler-Hammer.
   3. Square D Model.
   4. Siemens.
   5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA ICS 2, magnetic lighting contactor.

C. Configuration: Electrically or mechanically held, 2 wire control, as indicated on drawings.

D. Coil Operating Voltage: as indicated on drawings.

E. Poles: To match circuit configuration and control function with spare poles as indicated on drawings.

F. Contact Rating: Conductor overcurrent protection, considering derating for continuous loads.

G. Accessories:
1. Cover Mounted Pilot Devices: NEMA ICS 5, heavy-duty.
2. Selector Switch: ON/OFF/AUTOMATIC function, with rotary action.
3. Auxiliary Contacts: Two field convertible in addition to seal-in contact.
4. Relays: NEMA ICS 2.
5. Control Power Transformers: Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

H. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

2.2 SWITCHES

A. Manufacturers:
1. Hubbell Incorporated
2. Leviton Manufacturing Co., Inc.
3. Pass and Seymour/Legrand
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Specification Grade, toggle switch rated 120/277V 20A minimum.
1. Material: Plastic.
2. Color: By Architect.

C. Key Switch: Spade key type. Match non-key switch ratings.

2.3 SWITCH PLATES

A. Manufacturers:
1. Hubbell Incorporated.
2. Leviton Manufacturing Co., Inc.
3. Pass and Seymour/Legrand.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Specification Grade.
1. Material: Stainless steel.

2.4 OCCUPANCY AND DAYLIGHT SENSORS

A. Manufacturers:
1. As indicated on Symbol list and as indicated in plan details.
2. Substitutions: Section 01 60 00 - Product Requirements.

B. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 30 seconds to 12 minutes.

C. Furnish with manual override.

D. Operation: Silent.

E. Room Sensors: As indicated on Drawings.

2.5 PHOTOCELLS

A. Manufacturers:
1. Tork
2. AMF
3. Hubbell.
4. LC&D
5. Substitutions: Section 01 60 00 - Product Requirements.

B. General: Consist of sensor mounted as indicated on Drawings with adjustable photo eye. Device shall be mounted to rigid conduit and face north orientation. Sensor shall be 120V rated and shall control exterior lighting in concert with time clock, via contactor coil.

PART 3 EXECUTION

3.1 INSTALLATION

A. Mount switches, occupancy sensors and photocells as indicated on Drawings.

B. Install wiring in accordance with Section 26 05 19.

C. Use only properly color coded, stranded wire. Install wire sizes as indicated on Drawings. Install wire in conduit in accordance with Section 26 05 33.

D. Identify power wiring with circuit breaker number controlling load. When multiple circuit breaker panels are feeding into relay panel, label wires to indicate originating panel designation.

E. Define each dimmer's load type, shade settings, and set control functions.

F. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

G. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.

H. Systems Integration:
1. Equipment Integration Meeting:
a. Facility Representative to coordinate meeting between Facility Representative, Systems Integrator, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures prior to system startup

3.2 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Test each system component after installation to verify proper operation.

C. Test relays and switches after installation to confirm proper operation.

D. Confirm correct loads are recorded on directory card in each panel.

3.3 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate operation of the following system components:
1. Operation of switches.
2. Operation of each type of occupancy sensor and daylight controls.
3. Operation of photocell.

C. Furnish 1 day on-site system training to instruct Owner's personnel in operation and maintenance of system. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.4 CLOSEOUT ACTIVITIES

A. On-site Walkthrough:
1. Lighting Control System Manufacturer to provide a factory certified Field Service Engineer to demonstrate system functionality to the Commissioning Agent.

END OF SECTION

SECTION 260943 – NETWORK LIGHTING CONTROLS

PART 1- GENERAL

1.1 SUMMARY

A. The following specification details the minimum compliance and related criteria for a complete and fully operational distributed intelligence sensor and lighting control system for all interior lights.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 51 00 – Interior Lighting.
4. Section 26 56 00 - Exterior Lighting.
5. Section 27 05 26 – Grounding and Bonding for Communications Systems.
6. Section 27 05 29 – Hangers and Supports for Communications Systems.

1.2 REFERENCES

A. American National Standards Institute/ (ANSI) (www.ansi.org)
1. C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

B. Institute of Electrical and Electronic Engineers (IEEE) (www.ieee.org)
1. 802.3af-2003 – Power over Ethernet standard

C. International Electrotechnical Commission (www.iec.ch)
1. (IEC) 801-2 Electrostatic Discharge Testing Standard.

D. International Organization for Standardization (ISO) (www.iso.ch)
1. 9001:2000 – Quality Management Systems.

E. National Electrical Manufacturers Association (NEMA) (www.nema.org)
1. WD1 (R2005) - General Color Requirements for Wiring Devices.

F. Underwriters Laboratories, Inc. (UL) (www.ul.com)
1. 916 – Energy Management Equipment

G. Federal Communications Commission (FCC) (www.fcc.gov)
1. Title 47 CFR Part 15 Class A

1.3 SYSTEM DESCRIPTION

A. The lighting control system shall be capable of providing all of the following functions for all lighting:
2. Continuous dimming and automatic on/off controls.
3. Occupancy control.
4. Vacancy control.
5. Daylight harvesting.
6. Temperature sensing.
7. Load management.
8. Outage reports.
9. Metered energy savings reports.

B. The lighting control system shall be capable of continuous dimming and switching allowing each fixture to monitor its local environment and provide distributed control in response to environmental changes.

1.4 SUBMITTALS

A. Specification Conformance Document - Indicate whether the submitted equipment:
   1. Meets specification exactly as stated.
   2. Meets specification via an alternate means and indicate the specific methodology used.

B. Shop Drawings; include:
   1. Schematic (one-line diagram) of system.
   2. Wiring diagrams for alternative installation configurations.

C. Product Data: Catalog data sheets with performance specifications demonstrating compliance with specified requirements.

D. Sequence of Operation to describe how each component operates and how any building wide functionality is achieved.

1.5 CLOSOUT SUBMITTALS

A. Sustainable Design Closeout Documentation
   1. LIGHTING CONTROL SYSTEM Manufacturer to provide an Operation and Maintenance Manual that details the start-up procedure being performed including a process to follow, details on tests performed and an area that documents all test results.

1.6 QUALITY ASSURANCE

A. Manufacturer: manufacturer must have 5 years of experience in the manufacture of electronic field devices.

B. System components:
   1. Listed by UL specifically for the required loads. Provide evidence of compliance.
   2. Listed by FCC specifically for the required wireless communication protocols. Provide evidence of compliance.

1.7 APPROVALS

A. 10 day prior approval before bid date is required for alternate proposals.

B. Complete catalog data, specifications and technical information on alternate equipment must be furnished to the Architect and Owner at least 30 business days in advance of the submission of approved Construction Documents.

C. For wired alternatives, manufacturer shall provide wiring diagrams and architectural details of interconnecting wiring for power signal and control and a narrative describing in detail how the proposed alternate system meets the intent of the project. Contractor shall provide a labor cost (adder or deduction) to install the wired alternative to the LIGHTING CONTROL SYSTEM.

1.8 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 0 degrees to 40 degrees C (32 degrees to 104 degrees F).
   2. Relative humidity: Maximum 90 percent, non-condensing.
   3. LIGHTING CONTROL SYSTEM must be protected from dust during installation.
   4. Ambient temperature for Lighting Management Appliance: 10 degrees C to 35 degrees C (50 degrees F – 90 degrees F).

1.9 WARRANTY

A. Provide manufacturer's Enhanced 3 Year Limited Warranty:
   1. 3-year limited warranty for the replacement of defective system components from the date of system startup completion.

B. Contractor shall provide limited workmanship warranty for one year from customer acceptance.

C. A standard 0-10V dimmable ballast module warranty is (3) years; however when purchased with a LIGHTING CONTROL SYSTEM this warranty is extended to (5) years.

D. For ballasts and LED drivers, see section 265100 – Interior Lighting Fixtures, Lamps, and Ballasts: Fluorescent Electronic Dimming Ballasts, and LED drivers.

1.10 MAINTENANCE MATERIAL SUBMITTALS

A. The manufacturer shall make available to the End-User a method of ordering new equipment for expansions, replacements and spare parts.

B. The manufacturer shall make new replacement parts available for minimum of 5 years from date of manufacture.

C. The manufacturer shall make remanufactured parts available for a minimum of 10 years from the system's date of purchase.

D. The manufacturer shall provide extended support that can be purchased on an annual maintenance contract basis.

1.11 MAINTENANCE MATERIALS

A. Furnish four of each type of sensor.

B. Furnish twelve luminaire control units.

C. Furnish two Gateways.

D. Furnish six manual control stations.

PART 2 – PRODUCTS

2.1 1-3 ZONE LIGHTING CONTROLLER

A. MANUFACTURERS

1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products of Crestron Electronics, Inc., Rockleigh, NJ 07647, Phone (855) 644-7643, www.crestron.com or comparable products from a single manufacturer approved by Architect prior to bidding, with the following components and characteristics.

B. Provide 1, 2, or 3 zone lighting controller for switching or 0-10v zones. Unit shall operate as an autonomous lighting controller for the space. All sensors and zones within the space shall be controlled without the need for additional equipment.

C. Circuit Input: 100 – 277 VAC, 50/60 Hz. Input, one 16 amp

D. Zone Outputs

1. 1, 2, or 3 high inrush mechanically held relays for switching loads
   a. 1,000,000 cycle mechanically latching relays
   b. Zero-cross arc-less high inrush
   c. Air gap off protection on each channel
2. 0-10v dimming models shall include 0-10v 4 wiring dimming for each channel

E. Product

1. Crestron GLPP-SWCN (1 zone switching)
2. Crestron GLPP-1SW2CN (2 zones switching
3. Crestron GLPP-1SW3CN (3 zones switching
4. Crestron GLPP-DIMFLVCN-PM (1 zone 0-10v dimming with power monitoring)
5. Crestron GLPP-1DIMFLVCN2-PM (2 zones 0-10v dimming with power monitoring)
6. Crestron GLPP-1DIMFLVCN3-PM (3 zones 0-10v dimming with power monitoring)

F. GLPP SPECIFIC ACCESSORIES

1. Keypads
   a. Connects to lighting controller with class II (2) #18 AWG or greater conductors.
   b. Color shall be white.
   c. Scene Functions
      1) ROCKER (ON/OFF/hold to dim) or 4 Button (ON/SCENE 1/SCENE 2/OFF)
         a) Product: Crestron GLPPA-KP-W -S
   d. Zone Functions
      1) Rocker controlling zone 1 (ON/OFF/hold to dim)
         a) Product: Crestron GLPPA-KP1-W -S
      2) Rocker controlling zone 2 (ON/OFF/hold to dim)
         a) Product: Crestron GLPPA-KP2-W -S
      3) Rocker controlling zone 3 (ON/OFF/hold to dim)
         a) Product: Crestron GLPPA-KP3-W -S
      4) 4 Button controlling zones 1-3 (ZONE 1 toggle/ZONE 2 toggle/ZONE 3 toggle/OFF)
         a) Product: Crestron GLPPA-KP4-W -S

2. Motion Sensors
    a. Motion sensors shall be provided in spaces as shown on the Contract Drawings.
    b. Dual technology ultrasonic and passive infrared motion sensing.
    c. Lighting controller selectable occupancy (auto-on, auto off) and vacancy (manual-on, auto-off) modes.
    d. Vacancy time out shall be adjustable
    e. Equipped with 4-wire interface for direct connection to lighting controller enables IR handheld remote signals to be passed through the ceiling to the lighting controller.
    f. Coverage: 360 deg., 2000 sq. ft
    g. Ceiling or flush mounted
    h. Color shall be white
    i. Product: Crestron GLS-ODT-C-NS, GLA-IR-QUATRO-HD-COM1-24, GLA-DT-QUATRO-COM2-24, GLA-DT-CM-COM2-24, GLA-US-COM1-24, GLA-US-HALLWAY-COM1-24, GLA-IR-QUATRO-COM2-24.

2.2 4-8 ZONE LIGHTING CONTROLLER

A. MANUFACTURERS
    1. Basis-of-Design Manufacturer: Subject Smpliance with requirements, provide products of Crestron Electronics, Inc., Rockleigh, NJ 07647, Phone (855) 644-7643, www.crestron.com or comparable products from a single manufacturer approved by Architect prior to bidding, with the following components and characteristics.

B. Provide 4 or 8 zone lighting controller for switching or 0-10v zones. Unit shall operate as an autonomous lighting controller for the space. All sensors and zones within the space shall be controlled without the need for additional equipment.

C. 4 or 8 circuit inputs
    1. 100 – 277 VAC, 50/60 Hz. 16amp each

D. 4 or 8 zone outputs
    1. 100,000 cycle mechanically latching relays
    2. Air gap off protection on each channel
    3. 0-10v 4-wiring dimming for each channel (60mA max current sink)

E. 8 digital inputs

F. 4 motion sensor inputs

G. 4 daylight sensor inputs

H. Override port for UL924 life safety applications

I. Real time power monitoring on all channels (-PM models only)

J. 4 normally open isolated relays (-PM models only)

K. Product
1. Crestron GLPAC-DIMFLV4 -PM (4-CH controller)
2. Crestron GLPAC-DIMFLV8 –PM (8-CH controller)

2.3 CENTRALIZED PANEL SOLUTIONS

A. MANUFACTURERS
1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products of Crestron Electronics, Inc., Rockleigh, NJ 07647, Phone (855) 644-7643, www.crestron.com or comparable products from a single manufacturer approved by Architect prior to bidding, with the following components and characteristics.

B. PANEL CHARACTERISTICS
1. Panel shall be digitally addressable using serial or Ethernet communication from Control Processor Panel specified hereto after.
2. Lighting dimmers shall be compatible with drivers / ballasts and LEDs / lamps as listed in SS26 50 00 LIGHTING.
3. Dimmers shall be provided in quantities, control types, and rated for the connected load as shown on the Contract Drawings.
4. Line and load phases shall be coordinated per manufacturers recommendations.
5. Dimming modules shall be field replaceable.
6. Dimming panels shall be listed to UL508.
7. Lighting control panels shall be convection cooled without the use of moving parts.
8. Lightning Protection: can withstand 6 kV / 3 kA surge, as per IEC 61000-4-5 and ANSI/IEEE C62.41-1991
9. NEMA Type 1 enclosure, IP20 rated protection, for indoor use only; 16-gauge galvanized steel, surface wall mount; gray front cover with powder coated finish
10. Lighting control panels shall comply with NEMA PB 1 and UL 50 (CAN/CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CAN/CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).

C. FEED TYPES
1. Reference Contract Drawing schedules for required feed types and breaker ratings.
2. FEED-THROUGH (FT)
   a. No branch circuit overcurrent protection.
   b. Provide barriers as required to separate normal and emergency circuits in a single panel.

D. ZONE CONTROL MODULES
1. Hi-Inrush Switching
   a. 1,000,000 cycle mechanically latching relays
   b. Zero-cross arc-less high inrush
   c. Air gap off protection on each channel

2.4 USER INTERFACES

A. MANUFACTURERS

1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products of Crestron Electronics, Inc., Rockleigh, NJ 07647, Phone (855) 644-7643, www.crestron.com or comparable products from a single manufacturer approved by Architect prior to bidding, with the following components and characteristics.

B. KEYPADS

1. Provide keypad quantities and locations as specified herein and shown on the Contract Drawings.
2. Field-configurable remote keypad with auto-adjusting backlight illuminating replaceable, engraveable programmable buttons in number indicated, with white LED indicators, configured to fit in standard single-gang box.
3. Trimmed using decorator face plates.
4. Cresnet connected for power and communication
5. Maximum buttons: 8
6. Color shall be white.
7. Product: Crestron C2N-CBD-P-W -S

C. FACE PLATES

1. Provide decorator faceplates for all keypad devices.
2. Multiple devices adjacent to door jams shall be ganged together.
3. Decorator faceplates shall be white and shall match in texture and color the keypad devices.
4. Product
   a. FP-G1-W -S (1 gang faceplate)
   b. FP-G2-W -S (2 gang faceplate)
   c. FP-G3-W -S (3 gang faceplate)
   d. FP-G4-W -S (4 gang faceplate)

D. TOUCH SCREENS

1. TFT active-matrix color LCD touch screen
2. Projected capacitive, 5-point multi-touch technology
3. 24-bit 16.7M colors, and dual-window HD video, HDTV, and high-resolution RGB streaming multimedia, IP intercom, and web browsing capabilities. Dynamic graphics and text capability. Enables custom control screen programming.
4. 5 hard keys pushbuttons
5. Bidirectional 10/100 Mbps Ethernet communication.
6. H.264 and MJPEG streaming video.
7. 5.0 MP camera
8. Built-in microphone and speaker with multi-language voice recognition
9. Rava SIP intercom
10. Connected via IEEE 802.3af Class 3 PoE Powered Device
11. Surface mount over 2-gang or 3-gang electrical box.
12. Color: White.

13. Products
    a. Crestron TSW-760-W-S (7” white, 2-gang mounted)

E. XPanel Interface: Virtual Touch Screen
1. Touch screen user interface, network-connected lighting management interface running on Crestron lighting control processor to provide lighting control, daylight harvesting, occupancy sensing, lighting schedules and overall adjustment to system functionality
2. Virtual touch screen is to be accessible via computer or laptop interface furnished by other.
3. Access to XPanel shall be via browser based IP address or .EXE file application.
4. Product: Crestron XPANEL

2.5 SENSORS

A. MANUFACTURERS
1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products of Crestron Electronics, Inc., Rockleigh, NJ 07647, Phone (855) 644-7643, www.crestron.com or comparable products from a single manufacturer approved by Architect prior to bidding, with the following components and characteristics.
2. Contractor shall provide quantities and locations of sensors per the Contract Drawings and as required for turnkey commercial lighting control operation.

B. MOTION SENSORS
1. Dual-Technology Ceiling Mounted (networked)
    a. Detects movement within space while reducing false triggering or shutoffs while space is occupied. Combination of ultrasonic motion detection and passive infrared detection with internal microprocessor. Sensitivity is independently adjustable for installed conditions. Delayed time off adjustment. Walk-through mode.
    b. Equipped with 4-wire interface for direct connection to control bus.
    c. Includes connection port for remotely mounted photocell.
    d. Coverage: 360 deg., 2000 ft.2
    e. Set-up and commissioning parameters shall be configurable via a handheld wireless remote.
    f. Mounts to 3” octagon box
    g. Product: Crestron GLS-ODT-C-CN
2. Dual Technology Wall Mounted
    a. Detects movement within space while reducing false triggering or shutoffs while space is occupied. Combination of ultrasonic motion detection and passive infrared detection with internal microprocessor. Sensitivity is independently adjustable for installed conditions. Delayed time off adjustment. Walk-through mode.
    b. Equipped with 3-wire interface for direct connection to control system utilizing control processor
    c. Coverage: 110 deg horizontal., 1200 ft.2
    d. Mounts to 4” octagon box or surface mounted.
    e. Product: Crestron GLS-ODT-W-1200

C. DAYLIGHT SENSORS

1. Indoor Daylight Sensor (open loop)
    a. Continually monitors daylight entering window or skylight to enable daylight harvesting applications to provide control of room lighting based on presence of daylight. Equipped with 3-wire interface for direct connection to control system utilizing control processor; 24 VDC power from network control bus.
    b. Light sensitivity: 3 to 6,000 foot-candles
    c. Mounting: As indicated.
    d. Product: Crestron GLS-LOL
2. Exterior Daylight Sensor
    a. Sensor shall continually monitor the total ambient light level and can adjust the lighting as necessary to reach the desired light level. The sensitivity is adjustable so that a 10V signal matches full daylight and 0V matches total darkness. A built in visor provides more consistent readings by blocking direct sunlight, and also protects the lens from the elements.
    b. Sensor shall be installed facing north.
    c. Light Sensitivity: 5 to 750 foot-candles
    d. Power: 24 VDC
    e. Mounting: surface mount
    f. Product: Crestron GLS-LEXT

D. PARTITION SENSORS
1. Single sided diffuse reflective sensing technology.
2. Digital device with control bus connectivity.
3. Surface mounted to 1-gang back box.
4. Trim using decorator face plate to match mounting surface
5. Product: Crestron GLS-PART-CN

E. SENSOR INTERFACE MODULE
1. Sensor Interface Device: Integrates occupancy sensors and related sensors with control network. In separate enclosure. 4-wire bus providing 24 VDC power to network devices, with two independent sensing inputs.
2. Product: Crestron GLS-SIM

2.6 CONTROL PROCESSOR PANEL

A. Manufacturers
1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products of Crestron Electronics, Inc., Rockleigh, NJ 07647, Phone (855) 644-7643, www.crestron.com or comparable products from a single manufacturer approved by Architect prior to bidding, with the following components and characteristics.

B. Control Processor Panels shall be provided in quantities and locations per the Contract Drawings, or as required for a fully networked lighting control system.

C. Control Processor Panels shall be factory assembled in a UL508 panelshop.

D. Shall include but not be limited to the following equipment to support all lighting control devices.

1. Cabinets
    a. Cabinet shall be made of 16-gauge galvanized steel
    b. NEMA 1 rated
    c. All DIN rails and mounting accessories shall be furnished an properly installed.
    d. Product: Crestron DIN-EN
2. Processors
    a. Crestron 3-series control system
    b. Modular architecture supports multiple simultaneous running programs.
    c. Ethernet 10/100Base-T and Cresnet connected
    d. Astronomical time clock with events stored in non-volatile RAM
    e. Native BACnet/IP with support for up to 500 BACnet objects
    f. Built-In Web Server: IIS v.6.0
    g. SNMP remote management.
    h. Active Directory support.
    i. IPv6 ready.
    j. DHCP and DNS Support
    k. Native Email Client
    l. Remote Diagnostics
    m. Remote Program Loading and Administration
    n. SSL security plug in
    o. Support user assigned or dynamic IP address.
    p. Products
        1) Crestron DIN-AP3
        2) Crestron RMC3
3. Power Supplies
    a. Provide regulated 24 VDC power supplies as required to support lighting control equipment.
    b. 120 VAC input
    c. Product: Crestron DIN-PWS50
4. Hubs
    a. Provide Cresnet distribution hubs as required to support all Cresnet devices.
    b. Product: Crestron DIN-HUB

2.7 UL924 EMERGENCY OVERRIDE

A. Automatic Load Control Relays (ALCR)
1. 0-10v Loads
    a. UL924 listed 4-wire automatic load control relay shall bring life safety lights on to 100% on loss of power.
    b. 120/277 VAC
    c. Product: Crestron GLA-EPC-FLV

2. Switched Loads
   a. UL924 listed 2-wire automatic load control relay shall bring life safety lights on to 100% on loss of power.
   b. Products
      1) Crestron GLA-EPC-P-120 (120 VAC)
      2) Crestron GLA-EPC-P-277 (277 VAC)

B. Emergency Shunt Relays (ESR)
1. 2 or 3 Wire Phase Controlled Loads
   a. UL924 listed 2/3-wire emergency shunt relay shall bring life safety lights on to 100% on loss of power.
   b. Products
      1) Crestron GLA-ESR-120-3/4 (120 VAC)
      2) Crestron GLA-ESR-277-3/4 (277 VAC)

C. Phase Loss Sensor
1. Lighting control panels shown on the Contract Drawings as emergency life safety shall have override UL924 listed override ports.
2. Provide 3-phase loss sensor fed with normal power. Upon loss of any phase the phase loss sensor shall trip the emergency lighting control panel override port(s).
3. Product: Crestron GLS-PLS-120/277

2.8 PROGRAMMING AND CONFIGURATION SOFTWARE

A. Lighting system configuration software shall allow custom programming of embedded operating systems for control of lighting system.

B. Lighting system configuration software shall Provide a graphical symbol based programming and development environment.

C. The Lighting System Configuration software shall generate Custom Software Control Interface Modules for communication with compatible remote integrated systems.

D. The Custom Software Control Interface shall include the following control data:
1. Complete lighting system control functions.
2. System specific control sets for sub systems and supervisory systems.
3. The Custom Software Control Interface shall be capable of communicating the following data types:
4. Bidirectional digital and analog data communication.
5. Bidirectional serial data communication.

2.9 CONDUCTORS AND CABLING

A. Power Supply Side of Remote-Control Power Sources: Comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors."

B. UTP Cable: 100-ohm, UTP. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

C. Communications Control Cable, Non-Plenum Rated: 22 AWG data pair stranded bare copper, and 18 AWG powe12r pair stranded bare copper, Type CM.
   1. Product: Crestron CRESNET-NP.

D. Communications Control Cable, Plenum Rated: 22 AWG data pair, stranded bare copper and 18 AWG power pair, stranded bare copper, Type CMP, complying with NFPA 262.
   1. Product: Crestron CRESNET-P.

E. Communications High-Power Control Cable, Non-Plenum Rated: 22 AWG stranded bare copper data pair, and 12 AWG stranded bare copper power pair, Type CM.
   1. Product: Crestron CRESNET-HP-NP.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions.

B. Provide complete installation of system in accordance with Contract Documents.

C. Provide dedicated network between Gateways and Sensors.

D. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

3.2 SERVICE AND SUPPORT

A. Startup and Programming:
   1. Provide factory certified field service engineer to make minimum of two site visits to ensure proper system installation and operation under following parameters:
      a. Qualifications for factory certified field service engineer:
         1) Certified by the equipment manufacturer on the system installed.
      b. Make first visit upon completion of installation of LIGHTING CONTROL SYSTEM:
         1) Verify connection of sensor units to controllers and ballasts.
         2) Place sensors onto the user-provided floor plan in the lighting energy management server.
         3) Verify system operation control by control.
         4) Obtain sign-off on system functions.
      c. Make second visit to demonstrate and educate Owner's representative on system capabilities, operation and maintenance.

B. Training of customer representatives for Energy Management Software.
   1. Configuration software used to make system programming and configuration changes.

C. Tech Support:
   1. Provide factory direct technical support hotline 24 hours per day, 5 days per week.

3.3 CLOSEOUT ACTIVITIES

A. Training Visit:
   1. LIGHTING CONTROL SYSTEM Manufacturer to provide (2) days additional on-site system training to site personnel.

B. On-site Walkthrough:

1. LIGHTING CONTROL SYSTEM Manufacturer to provide a factory certified Field Service Engineer to demonstrate system functionality to the Commissioning Agent.

C. Training to be conducted using customer configured software and shall be conducted using the final programmed and configured lighting control system.

3.4 MAINTENANCE

A. Capable of providing on-site service support within 48 hours anywhere in continental United States and within 72 hours worldwide except where special visas are required.

B. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system startup.

END OF SECTION

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes two-winding transformers; shielded transformers; autotransformers; and buck-and-boost transformers.

B. Related Sections:
1. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA ST 1 - Specialty Transformers (Except General Purpose Type).
2. NEMA ST 20 - Dry Type Transformers for General Applications.

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. Department of Energy: DOE 2016 Energy Efficiency standard.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures Submittal procedures.

B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

C. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of transformers.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer
5. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: NEMA ST 20, factory-assembled, air-cooled, Energy Star rated, dry type transformers, ratings as indicated on Drawings.

C. Primary Voltage: 480 volts, 3 phase.

D. Secondary Voltage: 208Y/120 volts, 3 phase.

E. Insulation system and average winding temperature rise for rated kVA as follows:
1. 1-15 kVA: Class 185 with 115 degrees C rise.
2. 16-500 kVA: Class 220 with 150 degrees C rise.

F. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.

G. Winding Taps:
1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
2. Transformers 15 kVA and Larger: NEMA ST 20.

H. Sound Levels: NEMA ST 20.

I. Basic Impulse Level: 10 kV for transformers less than 300 kVA, 30 kV for transformers 300 kVA and larger.

J. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.

K. Mounting:
1. 1-15 kVA: Suitable for wall mounting.
2. 16-75 kVA: Suitable for wall, floor, or trapeze mounting.
3. Larger than 75 kVA: Suitable for floor mounting.

L. Coil Conductors: Continuous copper windings with terminations brazed or welded.

M. Enclosure: NEMA ST 20, Type 1. Furnish lifting eyes or brackets.

N. Isolate core and coil from enclosure using vibration-absorbing mounts.

O. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 SOURCE QUALITY CONTROL

A. Production test each unit according to NEMA ST20.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify mounting supports are properly sized and located including concealed bracing in walls.

3.2 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, in accordance with Section 26 05 33, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Support transformers in accordance with Section 26 05 29.
1. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by manufacturer.
2. Mount floor-mounted transformers on vibration isolating pads suitable for isolating transformer noise from building structure.
3. Mount trapeze-mounted transformers as indicated on Drawings.

D. Provide seismic restraints as required by the most recent adopted version of the State of Connecticut Building Code. .

E. Install grounding and bonding in accordance with Section 26 05 26.

F. Provide labeling in accordance with Section 260553.

G. Where primary disconnecting means is not within line of sight of the transformer. Provide permanent signage indicting the location of the disconnecting means.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION

SECTION 262413 - SWITCHBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes main electric service switchboard with ground fault protected bidirectional main circuit breaker, utility CT/PT compartment, customer metering compartment, Type 1 surge protective device, bidirectional PV interconnect branch device.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 53 - Identification for Electrical Systems.
3. Section 26 28 13 - Fuses.
4. Section 26 05 73 – Overcurrent Protective Device Coordination Study.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE C57.13 - Standard Requirements for Instrument Transformers.
2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
4. NEMA PB 2 - Deadfront Distribution Switchboards.
5. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.

C. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures and 26 04 00: Submittal procedures.

B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; and switchboard instrument details.

C. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.

D. Test Reports: Indicate results of factory production and field tests.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.

C. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver in shipping splits, individually wrapped for protection and mounted on shipping skids, and coordinated with maximum clear width openings into the facility.

C. Accept switchboards on site. Inspect for damage.

D. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 SEQUENCING

A. Sequence Work to avoid interferences with building finishes and installation of other products.

1.10 MAINTENANCE MATERIALS

A. Furnish two of each key.

B. Furnish two fuse pullers.

1.11 EXTRA MATERIALS

A. Furnish three of each size and type of fuse installed.

PART 2 PRODUCTS

2.1 MAIN DISTRIBUTION SWITCHBOARD

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer
5. Substitutions: Not permitted.

B. Product Description: NEMA PB 2, enclosed switchboard with electrical ratings and configurations as indicated on Drawings.

C. Device Mounting:
1. Main Section: Individually mounted and compartmented.
2. Distribution Section: Group mounted.

D. Bus:
1. Material: Copper with tin plating. Fully rated (no reductions).
2. Connections: Bolted, accessible from front for maintenance.
3. Insulation: Fully insulate load side bus bars.

E. Ground Bus: Extend length of switchboard.

F. Line and Load Terminations: Accessible from front only of switchboard, suitable for conductor materials and sizes as indicated on Drawings.

G. Utility Metering Compartment: Furnish metering transformer compartment for Utility Company's use, in accordance with Utility Company requirements.

H. Metering Compartment: Furnish metering transformer compartment for building service metering use, and separate metering packaged device from switchboard manufacturer for owner metering. Include kW/kVA, kWh, power factor, voltage per phase and neutral and peak kW (demand).

I. Pull Section: Size as indicated on Drawings. Arrange as indicated on Drawings.

J. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, insulated and braced for short circuit currents. Furnish continuous current rating as indicated on Drawings.

K. Enclosure: Type 1 - General Purpose.

L. Align sections at front and rear.

M. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

2.2 FUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer
5. Substitutions: Not permitted.

B. Product Description: NEMA KS 1, Type HD, load interrupter knife switch. Handle lockable in OFF position.

C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.

2.3 MOLDED CASE CIRCUIT BREAKER

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer.
5. Substitutions: Not permitted.

B. Product Description: NEMA AB 1, molded-case circuit breaker.

C. Main 1600 amp circuit breaker shall have Long time, Short time, Instantaneous and ground fault protection (LSIG) functions. These functions shall be similar to those functions found on a Square D PowerPact circuit breaker. Circuit breaker shall have energy reduction maintenance setting (ERMS) system. Provide the following;
a. Energy Reduction Maintenance Setting Switch (ERMS) designed for temporary arc-flash incident energy reduction during maintenance activities. Requires P or H trip unit.
1) For the Main circuit breaker above 1200 amps, provide a maintenance OFF ON selector switch on the compartment door to switch the circuit breaker instantaneous tripping characteristics to an alternate setting temporarily during maintenance activity.
2) Provide a lock feature for the ERMS switch so that it may be locked in either the OFF or ON maintenance mode position.
3) Provide a blue LED indicating light to indicate trip unit is in the ERMS mode.

2.4 SURGE PROTECTIVE DEVICE

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer
5. Current Technology.
6. Substitutions: Not permitted.

B. Product Description: IEEE C62.41, factory-mounted surge protective device, selected to meet requirements for high exposure (200,000A) and to coordinate with system circuit voltage. integral Type 1 surge protection at 480vY 3 phase with L-N=1200 L-G=1200 N-G=1200 and L-L 2000

C. Minimum surge current rating per phase: 320 kA.

D. Surge Protective device module shall be integral to switchboard and shall be fused.

2.5 INSTRUMENTATION

A. Provide a Square D Class 3020 PM8244 PowerLogic Power Meter with display. Device shall be panel mounted in the switchboard. Devices by others will be considered providing all of the following specifications are met.

B. The Power Meter shall be equipped with a two (2)-line by sixteen (16)-character LCD display for electrical circuit information.

C. The information displayed by the Power Meter shall include the following quantities:

1. Current, per-phase
2. Volts, phase-to-phase & phase-neutral
3. Real Power (kW), three-phase total
4. Reactive Power (kVAR), three phase total
5. Apparent Power (kVA), three phase total
6. Power Factor, true, per-phase & three-phase total
7. Frequency
8. Current Demand, per phase and neutral, present and peak
9. Real Power Demand (kWd), three phase total, present and peak
10. Reactive Power Demand (kVARd), three phase total, present and peak
11. Apparent Power Demand (kVAd), three phase total, present and peak
12. Real Energy (kWh), three phase total
13. Reactive Energy (kVARh), three phase total
14. Apparent Energy (kVAh), three phase total
15. Energy Accumulation Modes, signed, absolute, energy in, energy out
16. Watt-hour KYZ Pulse Initiator Output
17. Total Harmonic Distortion, Voltage
18. Total Harmonic Distortion, Current
19. Date/Time Stamping.
20. Communications port for Power Monitoring Systems communications and Modbus RTU communications.

D. The Power Meter shall be accurate to .25% for voltage and current sensing, .50% for power, energy, & demand sensing, and 1% for power factor sensing.

E. All information stored in the Power Meter shall be remotely accessible through data communications.

F. The Power Meter shall be UL Listed, rated for an operating temperature range of 0C to 55C and have an overcurrent withstand rating of 500 amps for 1 second.

G. The Power Meter metering inputs shall utilize industry standard current transformers (5A secondary CT's), have VT inputs for direct connection of VT leads to up to 600V, and adhere to UL standard 508 for dielectric voltage-withstand.

H. Each Circuit Monitor shall have built-in data communications to allow multipoint communication to multiple computer workstations, programmable controllers, and other host devices, at a minimum data rate of 9600 baud.

I. The data communications shall be optically isolated to provide reliable operation.

J. Power meter shall include a pulse output for interconnection with the Building Management System.

2.6 GROUND FAULT DEVICES

A. Provide integral ground fault sensing and protective device within switchboard as required by NEC. LSIG incorporation within the main circuit breaker device shall satisfy this requirement.

2.7 PHASE FAILURE RELAY

A. Provide integral phase failure relays within switchboard.

2.8 SOURCE QUALITY CONTROL

A. Furnish shop inspection and testing in accordance with NEMA PB 2.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify surface is suitable for switchboard installation. Coordinate the installation of a concrete housekeeping pad with

3.2 INSTALLATION

A. Install in accordance with NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Install fuses in each switch and coordinate sizes with connected load.

D. Install engraved plastic nameplates in accordance with Section 26 05 53.

E. Install breaker circuit directory.

F. Ground and bond switchboards in accordance with Section 26 05 26.

G. Label in accordance with Section 260553.

H. Service Switchboards:
1. Identification in accordance with Section 26 05 53.
2. Labeling & Identification:
   a. Indicate the maximum available fault current at the equipment, including the date the fault current calculation was performed. Label shall include warning for “Arc Flash Hazard” and requirement for “PPE protection”.

b. Indicate locations of sources and feeders for all services to the building (generator, PV array).

3. Installation of ERMS maintenance lockable selector switch and blue indicating light onto compartment door of the main circuit breaker. Installation of the IO module and the IFE module in accordance with manufactures recommendations.
   a. Set point for the ERMS instantaneous is based on manufactures recommendations. For Square D Power Pact circuit breaker (Basis of design) the default programmed setting to the instantaneous (Ii) set point is 2xIn.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.1.

D. Above testing shall be documented in writing and furnished as a part of the O&M manuals, and provided to CX agent prior to closeout.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust operating mechanisms for free mechanical movement.

C. Tighten bolted bus connections.

D. Adjust circuit breaker trip and time delay settings to values as indicated on Drawings or as instructed by Architect/Engineer.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Touch up scratched or marred surfaces to match original finish.

END OF SECTION

SECTION 262416 - PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes distribution and branch circuit panelboards.

B. Selective Coordination:
1. Fusible branch circuit panelboards overcurrent protective devices shall be selectively coordinated with all supply side (fed from both the normal and emergency source) overcurrent protective devices. Provide recommended fuses from a single manufacturer to maintain published minimum ampere coordination ratios. Consult manufacturer for coordination ratios for other types of fuses.

C. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 53 - Identification for Electrical Systems.
3. Section 26 05 73 – Overcurrent Protective Device Coordination Study.
4. Section 01 90 00 – Building Commissioning Requirements.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. UL 248 – Low-Voltage Fuses.
3. NEMA FU 1 – Low Voltage Cartridge Fuses.

B. National Electrical Manufacturers Association:
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
5. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
6. NEMA PB 1 - Panelboards.
7. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

C. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

E. Underwriters Laboratories Inc.:
1. UL 67 - Safety for Panelboards.
2. UL 1283 - Electromagnetic Interference Filters.
3. UL 1449 - Transient Voltage Surge Suppressors.

1.3 SUBMITTALS

A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

B. Product Data: Submit catalog data showing specified features of standard products.

C. Main disconnect ratings (if applicable):
1. Voltage and ampacity ratings of the disconnect.
2. Voltage, ampacity, and interrupting ratings of fuses.

D. Branch device ratings including:
1. Voltage, ampacity, and interrupting ratings of fused branch device.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

B. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

B. Fusible branch circuit panelboards shall be listed to UL 67.

1.6 MAINTENANCE MATERIALS

A. Furnish two of each panelboard key. Panelboards keyed alike.

B. Furnish 20% or minimum of three fuses of each rating and type of fuse installed.

C. Furnish a minimum of one spare fuse cabinet or as indicated on the drawings.

PART 2 PRODUCTS

2.1 DISTRIBUTION PANELBOARDS

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer
5. Substitutions: Not permitted.

B. Product Description: NEMA PB 1, circuit breaker type panelboard.

C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.

D. Minimum integrated short circuit rating: Calculated based on primary transformer available SCR.

E. Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

F. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated on Drawings.

G. Enclosure: NEMA PB 1, Type 1 cabinet box.

H. Cabinet Front: Surface door-in-door type, fastened with concealed trim clamps, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.

I. Provide fully rated (100%) main circuit breakers in Panelboards where indicated.

J. Provide SPD2 surge protective devices where indicated by the drawings.

2.2 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer.
5. Substitutions: Not permitted.

B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.

D. Minimum Integrated Short Circuit Rating: Calculated based on primary transformer available SCR and as indicated on plans.

E. SPD Devices: Provide integral panel mounted surge protective device modules within all 208/120 volt branch power panelboards.
1. IEEE C62.41surge protective device.
2. 200 kA short circuit current rating.
3. Minimum current rating per phase: 120 kA.

F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.

G. Enclosure: NEMA PB 1, Type 1.

H. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards.

I. Cabinet Front: Flush cabinet front with concealed hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's standard gray enamel.

J. Provide SPD2 surge protective devices where called for by the drawings.

2.3 FUSIBLE BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. Fusible Panelboards shall be Cooper Bussmann™ Quik-Spec™ Coordination Panelboards type QSCP.
2. Substitutions will be accepted only if the below requirements are met and written approval is provided from the engineer:
a. The electrical contractor supplies a written request to the engineer three weeks prior to the project bid date
b. The electrical contractor provides product documentation to prove complete compliance with specification and all pertinent codes and standards requirements as specified in this section.

B. Panelboard overcurrent protective device interrupting ratings shall be fully rated for the maximum available fault current and have a UL Listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA.

C. Construction:
1. Panelboard circuits 100A and less shall incorporate overcurrent protection and branch-circuit rated disconnecting means into a single integrated component.
2. Interiors shall be factory assembled.
3. Panelboard shall be equipped with a six-space spare fuse compartment for storing replacement branch circuit fuses. Spare fuse compartment shall be located behind locking panel door.
4. Bus bars shall be tin-plated copper with sufficient cross sectional area to meet UL 67 temperature rise requirements.
5. 200A/400A rated neutrals shall be standard.
6. Main lug conductor terminations:
a. MLO terminations shall be rated for 60/75°C, Cu-Al
b. Main disconnect terminations shall be rated for 75°C, Cu Only
7. NEMA 1 panelboards shall be field convertible for top or bottom incoming feed.

D. Main Disconnect:
1. Permanently installed lockout means shall be provided on the main disconnect for lockout tagout procedures.
2. Main disconnect shall be quick-make, quick-break type.

E. Branch Fused Disconnects:
1. Device shall have visible circuit ON/OFF indication with colored and international symbol markings.
2. Device shall provide open fuse indication via permanently installed neon indicating light.
3. Device shall be UL and cUL Listed 600Vac/200kA or 125Vdc/100kA voltage/short-circuit current rating, load-break disconnect with amp ratings and number of poles as indicated on the panelboard schedule.
4. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
5. Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.

6. No special tools shall be required for fuse removal.
7. Devices shall have bolt-on style bus connectors.
8. Device housing shall be clearly marked with device amperage.
9. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
10. Device shall provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A & 100A.

F. Main and Branch Circuit Overcurrent Protection
1. All overcurrent protective devices shall have a minimum UL Listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA.
2. Branch circuit overcurrent protection shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR finger-safe fuse with Class J* performance characteristics.
3. Main overcurrent protective devices shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR Class J time-delay fuses or Class J performance fuses.
4. Where panelboard main fuses are installed, fuses in panelboard branch circuits shall selectively coordinate with main fuses for all overcurrents up to 200kA.

G. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.

H. Minimum Integrated Short Circuit Rating: Calculated based on primary transformer available SCR and as indicated on plans.

I. Enclosure:
1. NEMA 1 enclosures shall be surface or flush mount as indicated in associated schedules or drawings.
2. Boxes shall be a nominal 20 inches wide and 5-¾ inches deep with wire bending space per the National Electrical Code.
3. Panelboard trim shall be supplied with lockable door covering all disconnect handles.
4. Panelboard trim shall be dead-front construction covering all energized parts.
5. Door-in-door type trim shall be provided for NEMA 1 enclosures where it is specified in the associated schedules or drawings.
6. Front trim shall be lockable. All lock assemblies shall be keyed alike with like NEMA rated enclosures.

J. Provide external SPD2 surge protective devices where called for by the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1.

B. Install panelboards plumb.

C. Install recessed panelboards flush with wall finishes.

D. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

E. Install filler plates for unused spaces in panelboards.

F. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads.

G. Install engraved plastic nameplates in accordance with Section 26 05 53.

H. Install a permanent label indicating the panelboard or transformer where the power supply to the panel originates.

I. Ground and bond panelboard enclosure according to Section 26 05 26. Connect equipment ground bars of panels in accordance with NFPA 70.

J. Define each lighting control circuit breaker, relay load type and assign to required zone, input and/or schedule.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

D. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

E. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

F. Above testing shall be documented in writing and furnished as a part of O&M manuals, and provided to CX agent prior to closeout.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION

SECTION 262726 - WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes wall switches; wall dimmers; receptacles; multioutlet assembly; and device plates and decorative box covers.

B. Related Sections:
1. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Outlet boxes for wiring devices.
2. Section 26 05 34 - Floor Boxes for Electrical Systems: Service fittings for receptacles installed on floor boxes.
3. Section 26 05 34 - Floor Boxes for Electrical Systems: Poke-through receptacles.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

B. Samples: Submit two samples of each wiring device and wall plate illustrating materials, construction, color, and finish.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 EXTRA MATERIALS

A. Furnish two of each style, size, and finish wall plate.

PART 2 PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
1. Hubbell Wiring Products.
2. Leviton.
3. Bryant.
4. Pass and Seymour.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA WD 1, General-Duty, AC only general-use snap switch.

C. Body and Handle: Color by Architect.

D. Ratings:
1. Voltage: 120 volts, AC.
2. Current: 20 amperes.

E. Ratings: Match branch circuit and load characteristics.

F. Specification grade device.

2.2 RECEPTACLES

A. Manufacturers:
1. Hubbell Wiring Products.
2. Leviton.
3. Bryant.
4. Pass and Seymour.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA WD 1, General-duty general use receptacle.

C. Device Body: Color by Architect

D. Configuration: NEMA WD 6, type as indicated on Drawings.

E. Convenience Receptacle: Type 5-20R.

F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

G. Specification grade device.

2.3 WALL PLATES

A. Manufacturers:
1. Hubbell Wiring Products.
2. Leviton.
3. Bryant.
4. Pass and Seymour.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Decorative Cover Plate: Stainless steel plate, natural brushed finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify outlet boxes are installed at proper height.

B. Verify wall openings are neatly cut and completely covered by wall plates.

C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install devices plumb and level.

B. Install switches with OFF position down.

C. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Install receptacles with grounding pole on top.

F. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

G. Install wall plates on switch, receptacle, and blank outlets in finished areas.

H. Connect wiring devices by wrapping solid conductor around screw terminal. Install stranded conductor for branch circuits 10 AWG and smaller. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.

I. Use jumbo size plates for outlets installed in masonry walls.

J. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

K. Provide GFCI type receptacles for all 20A, 125V receptacles in locker rooms with associated showering facilities.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 26 05 33 to obtain mounting heights as specified and as indicated on drawings.

B. Install wall switch 48 inches above finished floor.

C. Install convenience receptacle 18 inches above finished floor.

D. Install convenience receptacle 6 inches above counter or back splash of counter.

E. Coordinate installation of wiring devices with floor box service fittings provided under Section 26 05 34 and Section 26 05 39.

3.5 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 262813 - FUSES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fuses and spare fuse cabinet.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.3 DESIGN REQUIREMENTS

A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for the following components: wire, cable, bus structures, and other equipment. Design system to maintain component damage within acceptable levels during faults.

B. Select fuses to coordinate with time current characteristics of other overcurrent protective elements, including other fuses, circuit breakers, and protective relays. Design system to maintain operation of device closest to fault operates.

1.4 FUSE PERFORMANCE REQUIREMENTS

A. General Purpose Branch Circuits: Class RK1 (time delay).

B. Motor Branch Circuits: Class RK1 (time delay).

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data sheets showing electrical characteristics, including time-current curves.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual sizes, ratings, and locations of fuses.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.8 MAINTENANCE MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish two fuse pullers.

1.9 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.

B. Furnish three spare fuses of each Class, size, and rating installed.

PART 2 PRODUCTS

2.1 FUSES

A. Manufacturers:
1. Bussman.
2. Gould Shawmut.
3. Little Fuse.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated on Drawings.

C. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.2 SPARE FUSE CABINET

A. Manufacturers:
1. Bussman.
2. Gould Shawmut.
3. Little Fuse.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Wall-mounted sheet metal cabinet with shelves, suitably sized to store spare fuses and fuse pullers specified.

C. Doors: Hinged, with hasp for Owner's padlock.

D. Finish: Gray enamel.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install fuse with label oriented so manufacturer, type, and size are easily read.

B. Install spare fuse cabinet as indicated on Drawings or as directed by Owner.

END OF SECTION

SECTION 262819 - ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fusible and nonfusible switches.

B. Related Sections:
   1. Section 26 28 13 - Fuses.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA FU 1 - Low Voltage Cartridge Fuses.
   2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
   1. General Electric.
   2. Square D.
   3. Siemens.
   4. Eaton/Cutler Hammer.
   5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA KS 1, Type HD, enclosed load interrupter knife switch. Handle lockable in OFF position.

C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.

D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

E. Furnish switches with entirely copper current carrying parts.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.

C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

D. Furnish switches with entirely copper current carrying parts.

2.3 SWITCH RATINGS

A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.

B. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install enclosed switches plumb. Provide supports in accordance with Section 26 05 29.

B. Height: 5 feet to operating handle.

C. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 for product requirements.

D. Install engraved plastic nameplates in accordance with Section 26 05 53.

E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION

SECTION 262826 - ENCLOSED TRANSFER SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes transfer switches in individual enclosures.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. Underwriters Laboratories Inc.:
   1. UL 1008 - Transfer Switch Equipment.

1.3 SUBMITTALS

A. Product Data: Submit catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of enclosed transfer switches.

C. Operation and Maintenance Data: Submit routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

1.6 MAINTENANCE SERVICE

A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.

B. Furnish service and maintenance of transfer switches for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH

A. Manufacturers:
1. Asco.
2. Russelectric.
3. Onan.
4. Kohler.
5. Generac.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA ICS 10, automatic transfer switch.

C. Configuration: Electrically operated, mechanically held transfer switch, open transition.

D. Rating: 480/277 volt 3 phase 4 wire 4 pole switches:
1. 100 ampere nominal rating for Emergency Life Safety System.
2. 400 ampere nominal rating for Optional Standby System.

E. Interrupting Capacity: 100 percent of continuous rating.

F. Withstand Current Rating: 93kA rms symmetrical amperes, when used with molded case circuit breaker.

G. Product Features:
1. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, switch position.
2. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
3. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate source to normal source.
4. Transfer Switch Auxiliary Contacts: 2 normally open.
5. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 95 percent.
6. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent.
7. In-Phase Monitor and Time Delay Neutral: Inhibit transfer until source and load are synchronized.
8. Switched Neutral: Non-Overlapping contacts.

H. Automatic Sequence of Operation:
1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
2. Time Delay To Start Alternate Source Engine Generator: 0 to 60 seconds, adjustable (refer to paragraph 10).
3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
4. Time Delay Before Transfer to Alternate Power Source: 0 to 60 seconds, adjustable (refer to paragraph 10).
5. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.

6. Time Delay Before Transfer to Normal Power: 0 to 60 seconds, adjustable; bypass time delay in event of alternate source failure.
7. Time Delay Before Engine Shut Down: 0 to 15 minutes, adjustable, of unloaded operation.
8. Engine Exerciser: Start engine every 30 days; run for 20 minutes before shutting down. Bypass exerciser control when normal source fails during exercising period.
9. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.
10. Required emergency systems transfer switch and generator shall be configured in accordance with NFPA 70 to ensure emergency power is available within 10 seconds of failure of the normal supply. The Contractor shall coordinate starting and stabilization time with the generator supplier and set all time delays to ensure the required 10 second maximum time period is met.

I. Enclosure:
1. Enclosure: ICS 10, Type 1.
2. Finish: Manufacturer's standard enamel.

2.2 SOURCE QUALITY CONTROL

A. Furnish shop inspection and testing of each transfer switch.

B. Make completed transfer switch available for inspection at manufacturer’s factory prior to packaging for shipment. Notify Owner at least seven days before inspection is allowed.

C. Allow witnessing of factory inspections and tests at manufacturer’s test facility. Notify Owner at least seven days before inspections and tests are scheduled.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install engraved plastic nameplates in accordance with Section 26 05 53.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.22.3.

3.3 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers’ field services.

B. Check out transfer switch connections and operations and place in service.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust control and sensing devices to achieve specified sequence of operation.

3.5 DEMONSTRATION AND TRAINING

A. Demonstrate operation of transfer switch in bypass, normal, and emergency modes.

B. Provide a minimum of 2 hours instruction to Owner & personnel by manufacturer's authorized representative.

END OF SECTION

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes manual and magnetic motor controllers in individual enclosures.

B. Related Sections:
1. Section 26 28 13 - Fuses.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
5. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
6. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Test Reports: Indicate field test and inspection procedures and test results.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations and ratings of enclosed controllers.

C. Operation and Maintenance Data: Submit Replacement parts list for controllers.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 MANUAL MOTOR CONTROLLER

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer.
5. Cerus Industrial.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, 1 NO and 1 NC auxiliary contact, and toggle operator.

C. Enclosure: NEMA ICS 6, to meet conditions of installation.

2.2 FRACTIONAL-HORSEPOWER MANUAL CONTROLLER

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer.
5. Cerus Industrial.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and toggle operator.

C. Enclosure: NEMA ICS 6, to meet conditions of installation.

2.3 FULL-VOLTAGE NON-REVERSING CONTROLLERS

A. Manufacturers:
1. General Electric.
2. Square D.
3. Siemens.
4. Eaton/Cutler Hammer.
5. Cerus Industrial.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

C. Control Voltage: 120 volts, 60 Hertz.

D. Overload Relay: NEMA ICS 2; bimetal (electronic preferred).

E. Product Features:
1. Auxiliary Contacts General: NEMA ICS 2, 2 each, field convertible contacts in addition to seal-in contact.
2. Auxiliary Contacts for Atrium Smoke Control: Provide NEMA ICS 2, field convertible contacts to monitor 'Fan On' & 'Fan Off' conditions and 1 general purpose contact.
3. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty type.
4. Pilot Device Contacts: NEMA ICS 5.
5. Pushbuttons: Shrouded type.
6. Indicating Lights: LED type.
7. Selector Switches: Rotary type.
8. Relays: NEMA ICS 2.
9. Control Power Transformers: 120 volt secondary, in each motor starter. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

F. Combination Controllers: Combine motor controllers with disconnect in common enclosure, using fusible switch conforming to NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses. Obtain IEC Class 2 coordinated component protection.

G. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from [steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install enclosed controllers plumb. Provide supports in accordance with Section 26 05 29.

B. Height: 5 feet to operating handle.

C. Install fuses for fusible switches. Refer to Section 26 28 13 for product requirements.

D. Select and install overload heater elements in motor controllers to match installed motor characteristics.

E. Install engraved plastic nameplates. Refer to Section 26 05 53 for product requirements and location.

F. Neatly type label and place inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION

SECTION 263213 - ENGINE GENERATORS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes engine generator set, exhaust silencer and fittings, fuel fittings compatible with natural gas service, remote control panel, battery, and charger.

B. Required emergency systems transfer switch and generator shall be configured in accordance with NFPA 70 to ensure emergency power is available within 10 seconds of failure of the normal supply. The Contractor shall coordinate transfer switch time delays with the enclosed transfer switch supplier based on generator starting and stabilization time to ensure the required 10 second maximum time period is met.

C. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 53 - Identification for Electrical Systems.
3. Section 26 28 26 - Enclosed Transfer Switches.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
3. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.
4. NEMA MG 1 - Motors and Generators.

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. National Fire Protection Association:
1. NFPA 30 - Flammable and Combustible Liquids Code.
2. NFPA 110 - Standard for Emergency and Standby Power Systems.

1.3 SYSTEM DESCRIPTION

A. Description: Engine generator assembly and accessories to provide source of power for Level 1 and 2 applications in accordance with NFPA 110.

B. Capacity: 250 kW, at elevation of 500 feet above sea level, standby rating using specified engine cooling scheme.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate electrical characteristics and connection requirements. Include plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.

C. Product Data: Submit data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, and day tank.

D. Test Reports: Indicate results of performance testing.

E. Manufacturer's Field Reports: Indicate inspections, findings, and recommendations.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit instructions and service manuals for normal operation, routine maintenance, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of project.

B. Supplier: Authorized distributor of specified manufacturer with minimum three years experience.

1.7 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish one year manufacturer warranty.

1.8 MAINTENANCE SERVICE

A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.

B. Furnish service and maintenance of engine generator for one year from Date of Substantial Completion, and provide optional five year parts and labor maintenance agreement offering.

1.9 MAINTENANCE MATERIALS

A. Furnish one set of tools required for preventative maintenance of engine generator system. Package tools in adequately sized metal tool box.

B. Furnish two of each oil and air filter element.

PART 2 PRODUCTS

2.1 ENGINE

A. Manufacturers:
1. Cummins Metropower.
2. Kohler

3. Caterpillar.
4. Generac.
5. Substitutions: Section 26 04 00.

B. Product Description: Water-cooled in-line or V-type, four-stroke cycle, spark ignited internal combustion engine.

C. Rating: Sufficient to operate under 10 percent overload for one hour in ambient of 90 degrees F at elevation of 500 feet.

D. Fuel System: Natural Gas, minimum pressure 7-11" WC.

E. Engine speed: 1800 rpm.

F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

G. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Furnish remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.

H. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 volts AC.

I. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F. Radiator air flow restriction 0.5 inches of water maximum.

J. Engine Accessories: Lube oil filter, intake air filter, lube oil cooler, gear-driven water pump. Furnish water temperature gage, and lube oil pressure gage on engine/generator control panel.

K. Mounting: Furnish unit with suitable spring-type vibration isolators and mount on structural steel base.

2.2 GENERATOR

A. Manufacturers:
1. Cummins Metropwer.
2. Kohler
3. Caterpillar.
4. Generac.
5. Substitutions: Section 01 60 00 - Product Requirements {01600 - Product Requirements}.

B. Rating: 250 kW, at 0.8 power factor, 480Y/277 volts, 60 Hz at 1800 rpm.

C. Insulation Class: F.

D. Temperature Rise: 105 degrees C Continuous.

E. Enclosure: NEMA MG1, open drip proof.

F. Voltage Regulation: Furnish generator mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Furnish manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain.

2.3 GOVERNOR

A. Product Description: Electronic governor to maintain engine speed within 0.5 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes. Equip governor with means for manual operation and adjustment.

2.4 ACCESSORIES

A. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, sized in accordance with engine manufacturer's instructions.

B. Batteries: Heavy duty, diesel starting type lead-acid storage batteries, 170 ampere-hours minimum capacity. Match battery voltage to starting system. Furnish cables and clamps.

C. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.

D. Battery Charger: Current limiting type designed to float at 2.17 volts for each cell and equalize at 2.33 volts for each cell. Furnish overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input.

E. Line Circuit Breaker: NEMA AB 1, fully rated, molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole. Furnish battery voltage operated shunt trip, connected to open circuit breaker on engine failure. Unit mount in enclosure to meet NEMA 250, Type 1 requirements. Provide additional, fully rated load circuit breakers as indicated on project plans and specifications.
1. 300 ampere Optional Standby output circuit breaker.
2. 100 ampere Emergency Life Safety output circuit breaker.

F. Engine-Generator Control Panel: NEMA 250, Type 1 generator-mounted control panel enclosure with engine and generator controls and indicators. Furnish provision for padlock and the following equipment and features:
1. Frequency Meter: 45-65 Hz. range, 3.5 inch dial.
2. AC Output Voltmeter: 3.5 inch dial, 2 percent accuracy, with phase selector switch.
3. AC Output Ammeter: 3.5 inch dial, 2 percent accuracy, with phase selector switch.
4. Output voltage adjustment.
5. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, overspeed, and overcrank.
6. Engine start/stop selector switch.
7. Engine running time meter.
8. Oil pressure gage.
9. Water temperature gage.
10. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
11. Additional visual indicators and alarms in accordance with by NFPA 110.
12. Remote Alarm Contacts: Factory wire SPDT contacts to terminal strip for remote alarm functions in accordance with NFPA 110.

G. Remote Annunciator Panel: Flush mounted panel with painted finish and RS-485 communications with the engine generator. Furnish alarm horn, and indicators and alarms as follows:
1. High battery voltage (alarm).
2. Low battery voltage (alarm).
3. Loss of natural gas fuel supply (alarm).
4. System ready.
5. Anticipatory-high water temperature.
6. Anticipatory-low oil pressure.
7. Low coolant temperature.
8. Switch in off position (alarm).
9. Overcrank (alarm).
10. Emergency stop (alarm).
11. High water temperature (alarm).
12. Overspeed (alarm).
13. Low oil pressure (alarm).
14. Line power available.
15. Generator power available.
16. Lamp test and horn silence switch.

H. Weather-protective Sound Attenuating Enclosure: Reinforced steel housing allowing access to control panel and service points, with lockable doors and panels. Furnish fixed louvers, fuel tank, battery rack, and silencer. Housing shall attenuate sound pressure produced by generator, as measured 23 feet from assembly, to a level of 70 dBA maximum. Higher sound attenuation shall be incorporated into the enclosure design to ensure a maximum of 55 dba will be audible at the nearest property line during the daytime exercising schedule.

2.5 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Make completed engine-generator assembly available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner and Architect/Engineer at least seven days before inspection is allowed.

C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Architect/Engineer at least seven days before inspections and tests are scheduled.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install engraved nameplates in accordance with Section 26 05 53.

B. Ground and bond generator and other electrical system components in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.22.

C. Perform NFPA 110 emergency power system testing including full load testing and full load transfer.

D. Above testing shall be documented in writing and furnished as a part of the O&M manuals, and provided to CX agent prior to closeout.

3.3 MANUFACTURER'S FIELD SERVICES

A. Prepare and start up engine-generator assembly.

B. Submit written start up checklist and readings for all measurable conditions.

3.4 ADJUSTING

A. Adjust generator output voltage and engine speed to meet specified ratings.

3.5 CLEANING

A. Clean engine and generator surfaces. Replace oil and fuel filters with new.

3.6 DEMONSTRATION AND TRAINING

A. Furnish 2 hours of instruction each for two persons, to be conducted at project site with manufacturer's representative.

B. Describe loads connected to emergency and standby system and restrictions for future load additions.

C. Simulate power outage by interrupting normal source, and demonstrate system operates to provide emergency and optional standby power.

END OF SECTION

SECTION 264100 - FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes air terminals, interconnecting conductors, grounding, and bonding for lightning protection.

1.2 REFERENCES

A. Lightning Protection Institute:
   1. LPI 175 - Standard of Installation.

B. National Fire Protection Association:
   1. NFPA 780 - Standard for the Installation of Lightning Protection Systems.

C. Underwriters Laboratories Inc.:
   1. UL 96 - Lightning Protection Components.
   2. UL 96A - Installation Requirements for Lightning Protection Systems.

1.3 SYSTEM DESCRIPTION

A. Description: Conductor system protecting entire building and having UL Master Label.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.

C. Product Data: Submit catalog sheets showing dimensions and materials of each component, and include indication of listing in accordance with UL 96.

D. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

F. Certificate of Compliance: Submit certificate from Underwriter's Laboratories indicating approval of lightning protection systems.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 780.

B. Perform Work in accordance with UL 96A and furnish Master Label.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment with minimum five years documented experience and a member of Lightning Protection Institute.

B. Installer: Authorized installer of manufacturer with minimum five years documented experience and certified by Lightning Protection Institute.

C. Inspection Agency: Underwriter's Laboratories, Inc. (UL).

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Coordinate Work with roofing and exterior and interior finish installations.

PART 2 PRODUCTS

2.1 COMPONENTS

A. Manufacturers:
1. Erico.
2. Hager.
3. Alltec
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Listing: UL 96.

C. Air Terminals:
1. Material: Copper.
2. Configuration: Solid.
3. Use adhesive base for single-ply roof installations.
4. Air Terminal for Chimney: Lead-coated copper.
5. Grounding Rods: Solid copper.
6. Ground Plate: Copper.

7. Conductors:
   a. Material: Copper.
   b. Configuration: Cable.

D. Connectors and Splicers: Bronze.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with UL 96A.

B. Connect conductors using mechanical connectors.

C. Conceal interior conductors within building finishes. Conceal exterior conductors where practical.

D. Bond exterior metal bodies on building to lightning protection system, and provide intermediate level interconnection loops 60 feet on center.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform inspection and testing in accordance with UL 96A.

END OF SECTION

SECTION 264500 - PHOTOVOLTAIC SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Each and every Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this section shall also be bound by the Documents identified in Division 1.

1.2 SUMMARY

A. Section includes complete photovoltaic system including the following
   1. Solar electric modules
   2. Racking System
   3. Grid Tied Inverters
   4. Web Based System Monitoring
   5. Surge Protection
   6. Utility Meter
   7. Labeling

B. Related Sections:
   1. Section 07 5419 – Polyvinyl Chloride (PVC) Roofing
   2. Section 07 8413 – Penetration Firestopping: Product requirements for firestopping for placement by this section
   3. Section 07 7200 – Roof Accessories.
   4. Section 26 0501 – Basic Materials and Methods
   5. Section 26 0526 - Grounding and Bonding for Electrical Systems.

1.3 REFERENCES

A. North American Board of Certified Practitioners (NABCEP).

B. Institute of Electrical and Electronics Engineers:
   1. IEEE 1547 - Standard for Interconnecting Distributed Resources with Electric Power Systems.
   2. ANSI/IEEE Standard C62.41, Guide for Surge Voltages in AC Power Circuits.

C. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:
   1. UL 1703 – Flat-Plate Photovoltaic Modules and Panels
   2. UL 1741 – Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy resources.

1.4 BASIS OF DESIGN

A. The system is based on string inverters connected to power optimizers mounted to the PV module frame. Each power optimizer shall serve two PV modules. The design of the system is based on specific manufacturer’s equipment as indicated on the drawings. Acceptable substitutions of equipment will be considered, however deviations from the design will require the contractor to provide revised documentation for Permitting, Utility interface, and grant

application. Documentation shall include engineering calculations for system capacities (min/max), wire sizing, and inverter/module compatibility. If substitutions from basis-of-design system require additional structural work to the roof or building the Contractor shall provide the additional structural work at no additional cost to the Owner.

B. Array and branch circuit arrangement, as indicated on the drawings, is specific to the module and inverter manufacturer listed. Any deviation from the manufactures listed in the schedules on the drawings will require additional calculations and design by the contractor.

C. Acceptable alternate equipment shall have efficiencies within +/-3% for Modules and +/-3% for inverters.

D. Structural Engineering: The roof and structure of the building is limited in its capacity to support the weight of the PV system. The designed system includes several ballasted PV arrays and several structurally connected PV arrays. The ballasted system shall average not more than 6 pounds per square foot. The structurally connected PV array shall be connected to structural steel and all penetrations shall be coordinated and compatible with the roofing systems. As part of the basis of design the contractor shall provide stamped and signed drawings by a structural engineer that cover racking components, attachments and PV system design criteria.

1.5 EXTRA MATERIALS

A. Provide (4) solar modules and (2) power optimizers as attic stock.

1.6 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings:
1. Indicate voltage (Maximum, Minimum, and Open Circuit), voltage AC, Ampacity string size, inverter characteristics, and physical sizes for major equipment.
2. Indicate total kW for project matching design criteria.
3. Provide weight of entire system including ballasting (where applicable). Provide plan indicating exact weight and location of ballasts for Structural Engineer Review. Provide plan indicating exact location of structural steel connections.
4. Provide 3-line diagram of entire system.
5. Provide Installers North American Board of Certified Energy Practitioners (NABCEP) certification certificate.
6. Provide a copy of the Utility interconnection application.
7. Provide PE stamped roof drawing showing final layout of racking system and structural details. Refer to section 2.2 and 2.3 for additional requirements.

C. Product Data: Submit catalog data showing specified features, capacities and ratings of products provided.

1.7 CLOSEOUT SUBMITTALS

A. Section 017700 - Closeout Procedures.

B. Project Record Documents: Record actual locations of modules, inverters, string locations and Junction boxes and record actual circuiting arrangements.

C. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals, and warrantee information.

1.8 QUALIFICATIONS

A. Manufacturer of equipment
   1. Company specializing in manufacturing products specified in this section and listed as eligible equipment by the State of California Energy Commission.
   2. Equipment shall be UL listed.

B. Contractor: Installer shall be a “Certified PV Installation Professional” under the North American Board of Certified Practitioners (NABCEP).

C. Installer shall be an approved solar photovoltaic contractor by Connecticut Green Bank.

1.9 APPLICATIONS AND UTILITIES

A. Contractor shall provide a completed Interconnection Application to the utility company as required for connection of the Photovoltaic System to the electric utility grid. Contractor shall include the costs and Utility Fees for submitting application, witness tests, and Utility Solar Meter as required by the utility.

B. Coordinate and follow up with utility company for the connection of the system to the grid and provide a Utility Net Meter. Obtain agreements with the utility company on behalf of the owner.

C. Contractor shall include all cost associated with completing applications, follow up with agencies and utilities, application and witness tests costs by the utility and securing agreements on behalf of the owner.

D. Contractor shall provide witness test procedure to the utility company per their requirements and acquire witness test approvals from the utility company. Coordinate a time for the witness test with the utility company and perform the test per utility company requirements. Contractor is responsible to be present for the test, perform the test, make any adjustments as required, and provide any tools, meters, etc. as the utility company requires for completion of the test.

1.10 WARRANTY

A. All warranties listed herein shall be inclusive of labor and equipment and shall start at date of acceptance by commissioning agent and continue for a period of 2 years (unless noted otherwise in this section).

PART 2 PRODUCTS

2.1 SOLAR ELECTRIC MODULES

A. Manufacturers:
   1. LG Electronics (Basis of Design).
   2. SunPower
   3. QCells
   4. Equivalent modules will be acceptable if they meet or exceed the performance of the basis of design module and of similar construction and physical dimension and weight.

5. Substitutions: Section 01 61 00 – Basic Product Requirements

B. Product Description: Modules shall be mono/poly-crystalline solar cells with the following characteristics.
   1. 60 cell module (LG335N1C-A5)
   2. Module Efficiency: 19.6%
   3. STC Watts: 335
   4. Output Tolerance: -0% to +3%
   5. Maximum system voltage: 1000V
   6. MPP Voltage: 34.1V
   7. MPP Current: 9.83A
   8. Outside dimensions: 66.38” x 40” x 1.57”
   9. Weight: 39.68 lbs
   10. High transmission tempered glass
   11. Output Linear Warranty of Pmax:
      a. 1st year: 98%
      b. After 1st year: 0.55% annual degradation
      c. 25 year: 84.8%

C. Module connection shall be MC4 12AWG or equivalent for easy connection and disconnection of individual modules. Wiring, conduit, junction boxes, etc shall be neatly arranged.

D. Frame shall be anodized aluminum.

E. Product Warrantee: Materials and Workmanship - 12 years.

2.2 BALLASTED RACKING SYSTEM

A. Manufacturers:
   1. Aerocompact (Basis of Design)
   2. Unirac
   3. Schletter

B. Submittal Requirements: Contractor shall provide a roof plan stamped by a Connecticut Professional Engineer showing structural calculations of the racking system to be provided. Package shall include at a minimum:
   1. Roof layout showing final module configurations
   2. Structural calculation sheet demonstrating system selection based on wind and snow loads.
   3. Detail of ballast method
   4. Section of the rack

C. Product Description: Self-ballasted solar racking system with the following characteristics:
   1. 10 degree tilt angle
   2. Distributed Weight shall not exceed 6 lbs/sq.ft. unless coordinated, documented and approved otherwise by the Structural Engineer.
   3. Shall be self-ballasted with roof anchors
   4. Material shall be aluminum
   5. Hardware shall be stainless steel
   6. Warranty shall be 15 years minimum

D. Racking system shall be able to easily accommodate the specified modules without making modifications to the racking system on site and utilizing the manufacturer’s standard fasteners.

E. Stainless steel fasteners shall be used on the racking system.

F. Systems shall meet or exceed the minimum structural requirements including wind and snow loads.

G. Provide all required manufacturer approved hardware for a complete and functional installation, including but not limited to mounting brackets for devices such as optimizers, inter-row high voltage wiring management, wind deflectors, conduit supports, approved electrical boxes rated for exterior environment, etc.

2.3 STRUCTURALLY CONNECTED RACKING SYSTEM

A. Manufacturers:
1. Roofscreen MFG., Inc : Silverback Solar (Basis of Design)
2. Preformed Line Products
3. Schletter

B. Submittal Requirements: Contractor shall provide a roof plan stamped by a Connecticut Professional Engineer showing structural calculations of the racking system to be provided. Package shall include at a minimum:
1. Roof layout showing final module configurations
2. Roof layout showing final racking configurations
3. Roof layout showing final location of structural connections to building steel
4. Structural calculation sheet demonstrating system selection based on wind and snow loads.
5. Detail of structural connection
6. Section of the racking configurations

C. Product Description: Structurally connected racking system
1. Custom fabricated roof connected racking system to compliment curved architectural building elements
2. Material shall be aluminum
3. Hardware shall be stainless steel
4. Warranty shall be 20 years minimum

D. Racking system shall be able to easily accommodate the specified modules without making modifications to the racking system on site and utilizing the manufacturer’s standard fasteners.

E. Stainless steel fasteners shall be used on the racking system.

F. Systems shall meet or exceed the minimum structural requirements including wind and snow loads.

G. Provide all required manufacturer approved hardware for a complete and functional installation, including but not limited to mounting brackets for devices such as optimizers, inter-row high voltage wiring management, wind deflectors, conduit supports, approved electrical boxes rated for exterior environment, etc.

H. All PV modules and key components shall be accessible and serviceable from below the mounting system.

2.4 STRING INVERTERS

A. Manufacturers:
1. Solaredge 3-phase String Inverters (Basis of Design)
2. SMA 3-phase string Inverters
3. Solectria 3-phase string inverters
4. Substitutions: Section 01 61 00 – Basic Product Requirements

B. Product Description: String inverters shall be mounted to a custom fabricated support at the location shown on plans, and tied to power optimizers mounted directly behind modules by utilizing product specific wiring harness and cables. The Inverters shall have the following characteristics:
1. UL 1741 listed.
2. Output: As indicated on drawings.
3. 3 phase, 480Y/277V, 60HZ output
4. Designed for installation where there is full sun, driving rain and drifting snow.
5. Power Factor = 1 (adjustable from -0.8 to +0.8)
6. Outdoor NEMA 3R enclosure.
7. Grounding: Grounding shall be provided as per manufacturer installation instructions and per NEC Art. 690.
8. Rapid Shutdown: Provide Solaredge 3-phase string inverter rapid shutdown kit for each inverter.

C. Capacity: String inverters shall be sized to match the module and overall system production taking into account record low temperature and average high temperatures.

D. Communication Capabilities: Connection to building's network via CAT6 wiring.

E. Product Warrantee: 12 years.

2.5 POWER OPTIMIZERS

A. Manufacturers:
1. Solaredge Power Optimizer (Basis of Design)
2. Tigo Power Optimizer
3. Innovative Solar Inc.
4. Substitutions: Section 01 61 00 – Basic Product Requirements

B. Product Description: Power optimizers shall be mounted directly behind modules by utilizing product specific wiring harness and cables. Power Optimizer output circuits shall be circuited to string inverters as indicated on drawings. The power optimizers shall have the following characteristics:
1. UL 1741 listed.
2. IEC62109-1 (Class II safety)
3. Output: 15Adc, 85Vdc
4. Designed for installation where there is full sun, driving rain and drifting snow.
5. Power Factor = 1 (adjustable from -0.8 to +0.8) set at the string inverter.
6. Outdoor IP68/NEMA 6P enclosure.
7. Grounding: Grounding shall be provided as per manufacturer installation instructions and per NEC Art. 690.

C. Capacity: Power optimizer/Module string quantities shall be sized following manufacturer recommendations and taking into account record low temperature and average high temperatures.

D. Product Warrantee: 25 years.

2.6 CABLE TIES

A. Manufacturers:
1. Partex Marking Systems (Basis of Design)
2. Substitutions: Section 01 61 00 – Basic Product Requirements

B. Product Description: Cable ties for securing DC wiring to PV racking. Wiring shall be neat and organized by utilizing cable ties and securing the wiring to the frame of the racking system. Wiring shall not come into contact with the roof.
1. Cable ties shall be 316 stainless steel with polyester coating.

2.7 WEB BASED MONITORING SYSTEM

A. Manufacturers:
1. Solaredge Control and Communication gateway (Part#SE1000-CCG-G)
2. Substitutions: Section 01 61 00 – Basic Product Requirements

B. Product Description: Provide a web based monitoring system that records and displays historical and real time PV production in graphical form for each individual module/inverter pair.

C. System shall report revenue grade data with instantaneous and historical data capabilities. Historical data shall include daily, weekly and monthly data for a period of 5 years.

D. Data access shall be available via the internet 24 hours a day, 7 days a week.

E. System shall include all necessary communication wiring, connections and meters for complete operational system.

F. Contractor shall connect Solar Edge monitoring system to the School's Switch/router for internet access, install, test and run software with the aid of the School's IT professional. Contractor shall cooperate and coordinate with the School's IT professional.

G. Provide online software setup of entire system, including graphical representation of modules/inverters in plan view showing them in their final location on the Roof plan. This is a critical item to provide a means for the Owner to troubleshoot individual inverters and the associated PV arrays. Provide Owner with full access login credentials.

H. Cooperate and grant access of the monitoring system to the Building Management System (BMS) provider for purposes of displaying real time information on the BMS via website link and credential login. Communication to the BMS shall be Bacnet compatible and configured with the BMS system for real time and historical PV array data reporting.

2.8 SURGE PROTECTION

A. Manufacturers:
1. Midnite Solar Surge Protection Device (#MNSPD-300-AC)
2. Substitutions: Section 01 60 00 - Product Requirements

B. Provide AC Surge Protection Device for PV1
   1. Design: Metal Oxide Varistor
   2. Maximum Current: 57kA
   3. Maximum Energy: 560 joules each section, 1120 joules full device
   4. Maximum Number of Surges: Unlimited
   5. Response Time one milliamp test: 1 nanoseconds
   6. Leads: (3) 24" #12 THHN

2.9 UTILITY METER

A. Manufacturers:
   1. Net meter as required by the Utility Company.

B. Product Description: Provide a three phase revenue meter as required by the Utility Company.

2.10 LABELING

A. Product Description: Labels shall be in accordance with the latest applicable edition of NFPA70 (National Electrical Code), NFPA1, ANSI Z535.4, and as required by the local Authority Having Jurisdiction.

B. Provide Lamacoid (3-ply laminated engraving plate) 11"x17" one-line diagram that is permanently mounted in the main electrical room. One-line shall show all interconnections of the PV system to the electrical distribution system as well as all disconnects and physical locations similar to the electrical riser diagram provided in the contract documents. Lamacoid placard shall be white with black lettering; shutoff switches shall be indicated with red characters.

C. Provide Lamacoid (3-ply laminated engraving plate) 11"x17" Site Plan that is permanently mounted in the main electrical room. Site Plan shall show all interconnections of the PV system to the electrical distribution system as well as all Disconnects, Inverters and roof mounted PV arrays. Lamacoid placard shall be white with black lettering; shutoff switches shall be indicated with red characters.

D. Labels located outdoors shall be weather and sunlight resistant. Labels shall be typewritten and permanently affixed. Provide reflective labels as per NEC requirements.

E. Provide additional labelling as indicated on contract documents.

PART 3 EXECUTION

3.1 UTILITY INTERCONNECTION

A. Utility Company Interconnection Application: Provide documentation required by the Utility Company for interconnection of the PV system to the Utility grid and installation of the Net-Meter.
   1. Secure Interconnection Agreement from the Utility Company and schedule a witness test and interconnection time with the Utility Company when the system has been installed, tested and commissioned by the contractor. Include Utility Witness Test and other associated Fees.
   2. Submit Interconnection agreement and associated fees to the Utility Company prior to start of work and establish a schedule with Utility Company so as not to delay the

project waiting for final connection. Schedule shall be mutually agreeable to contractor, owner and the Utility Company and be within the time frame of the overall project completion date.

3. Provide witness test procedure to the Utility Company for approval prior to witness test.

3.2 PERMITS

A. Permitting: Identify and apply for all permits required for installation of the Photovoltaic System. Include all associated Permit fees in bid.

1. Coordinate and schedule the final inspection with the local authority having jurisdiction.
2. If contractor has selected substitutions to product specified, contractor must provide revised documents that indicate the required changes to the project based on the substitutions. The documents shall be stamped and signed by a Professional Engineer and submittal to the inspectors for review with the permit application. Substitutions must be approved through the shop drawing submission process.

3.3 INSTALLATION

A. Under no circumstances shall a ballast block, framing member, junction box, conduit, architectural element or any other item shade the modules. Plan out locations of conduits, conduit roof penetrations, junction boxes, structural steel racking connections, etc., prior to installation. Notify Engineer of any conflicts that cannot be resolved prior to installation.

B. Provide schedule for all work for approval by Construction Manager and Owner. Schedule shall be in Gant Chart format indicating major milestones, critical path items, and total length of time for each milestone and project as a whole.

C. Installation shall meet the requirements of local, State, Federal, and OSHA requirements. Installation shall be in compliance with the State Building Code and National Electrical Code.

D. The system shall maintain roof and structural integrity. Coordinate with the roofing contractor to ensure that the building roof warranty and the integrity of the roof itself shall not be compromised by the installation.

E. Site shall be kept secure and free of excessive debris and in safe condition during the construction period. Site shall be left “broom clean” after work is complete and at the end of each work day.

F. Properly secure the site during construction to ensure no tampering, vandalism, theft or accidents occur while the site is in an unfinished state. Maintain personnel on site to monitor activities and prevent unauthorized personnel from entering the construction area where partially installed systems may be present. Secure and make safe all electrical wiring and connections.

G. The use of ferrous metals, wood, or plastic components are not acceptable. Provide stainless steel fasteners and aluminum support structures. Special attention shall be paid to minimize damaging existing structure (if applicable) and roof with sharp edges, exposed fasteners or structure during construction.

H. Wiring

1. Wiring shall be in accordance with Section 690 of the National Electrical Code. Wiring shall have a temperature rating of 90 degree C or higher.

2. Exposed electrical conduits shall be rigid galvanized. Exposed cables shall be UV resistant.
3. Outdoor enclosures shall be NEMA 4 or as indicated on plans.
4. Conduits on roof shall be mounted on high-density polyethylene (HDPE) supports such as Pipe Pier or equivalent. Supports shall be compliant with the roof membrane.

3.4 LABELLING AND IDENTIFICATION

A. Provide plan layout of array with each inverter serial number labelled on the plan in its final location. Submit plan with as-builts for Owner's future use.

B. Provide labeling in accordance with the latest applicable version of National Electrical Code, and as required by fire marshal and any other local authority having jurisdiction.

3.5 DELIVERY, STORAGE, AND HANDLING

A. PV modules and system components shall be delivered to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations.

B. Maintain the integrity of the installation site during delivery, handling and installation, including layout mats, insulation/plywood layers, etc. Any damage to the roof surface or landscaping shall be identified and repaired.

C. Cranes shall be in compliance with local codes and requirements.

D. Each module, inverter, and combiner box shall be physically inspected for defects and damage and replaced as necessary.

E. Do not place pallets of equipment, modules or ballast directly on roof. Ballast blocks shall be spaced out to avoid roof or structural damage.

3.6 FIELD QUALITY CONTROL

A. Provide all terminations and connections of electrical wiring fully tightened, secured and strain relieved as appropriate. Protect all exposed wiring whips, etc. in a neat and organized fashion.

3.7 COMMISSIONING AND TESTING

A. Provide testing in accordance with the Utility Company's Interconnection Agreement.

B. Provide testing and demonstration of system per the inspection process as described in Utility Company's Interconnection Agreement.

C. Provide a system safety inspection and start up that includes the following documented tests.
1. Inverter start-up tests as specified by the inverter manufacturer as outlined in the inverter operation manual.
2. Provide readings of actual versus predicted power.
3. Loss of grid power where inverter automatically and immediately turns off and does not connect to the utility until 5 minutes after utility power is restored.
4. Random Module shading
5. Data Monitoring check out. Including internet conductivity and display.
6. Measure Voc of every source circuit.

7. Measure AC power and compare predicted power.
8. Label all wiring terminations and enclosures.
9. Inspect PV array quick connectors and fully mate wire connectors.
10. Clean debris off the modules and visual inspect modules to identify and replace broken or damaged modules.

D. Correct any deficiencies uncovered by the testing prior to commissioning system.

E. Clear site of all tools and materials required for construction and installation.

F. Measure system outputs as follows and provide written documentation to Engineer for baseline system performance:
1. Establish initial system output to prove that the system is performing as it is designed and to establish a baseline to use for warranty.
2. Include voltage, amps, power output tests.
3. Test radiation levels at time of tests and note for reference.
4. System measurements shall be performed and logged on a clear sunny day.

3.8 OPERATING AND MAINTENANCE MANUALS

A. Refer to section 01 7700 for additional Closeout Procedures requirements

B. Refer to section 01 7823 for additional O&M Data Requirements.

C. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty, 3-ring, vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder. Provide a digital copy of all documents in a storage drive to the owner (USB flash drive).

D. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. As built plans showing the final placement of all panels, disconnects, combiner boxes, connections (tags) and conduit placement.
3. As built electrical plans, including three line diagrams, showing the final placement of electrical equipment.
4. Manufacturer's printed operating procedures to include start-up, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
5. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
6. Baseline performance readings from testing activities.
7. Trouble shooting guidelines.
8. Emergency instructions.
9. Contact information for technical assistance and parts ordering.
10. Copies of warranties.
11. Provide plan layout of array with each inverter serial number labelled on the plan in its final location. Submit plan with as-builts for Owner’s future use.
12. Approved Shop Drawings and Product Data.

3.9 TRAINING

A. Provide training in accordance with Specification Section 269950 – Electrical Systems Commissioning

END OF SECTION

SECTION 265100 - INTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes interior luminaires, lamps, ballasts, and accessories.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 09 43-Network Lighting Controls.
4. Section 26 56 00 - Exterior Lighting.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI C82.11 - American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.
2. ANSI C82.4 - American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

B. International Engineering Society of North America:

1. IESNA LM-79: Approved Method- Electrical and Photometric Measurements of Solid-State Lighting Products.
2. IESNA LM-80: Approved Method for Measuring Lumen Maintenance of LED light Sources.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer.

C. Product Data: Submit dimensions, ratings, and performance data:

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 LM-79 and IESNA 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: Photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
c. TM-21 report for L70 rating at color temperature specified.

D. 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.

E. Samples: Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.

F. 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.

G. Qualification Data: For testing laboratory providing photometric data for luminaires.

1. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
3. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.
4. Sample warranty.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 MAINTENANCE MATERIALS

A. Furnish two of each plastic lens type.

B. Furnish twelve replacement lamps for each lamp type installed.

C. Furnish two of each ballast and LED driver type.

PART 2 PRODUCTS

2.1 INTERIOR LUMINAIRES

A. Manufacturers:
1. Manufacturers represented by Apex Lighting.
2. Manufacturers represented by Reflex Lighting.
3. Manufacturers represented by Lighting Affiliates.
4. Manufacturers represented by Vanguard Lighting.

B. Substitutions:
1. Substitutions: Section 26 04 00 - Product Requirements and as follows:
a. Approved equals shall be accepted for review with the proposed substitute fixture meeting the following minimum requirements:
1) Be of the same general size, style and shape, including but not limited to lens construction and shading.
2) Be of equal or better quality and construction.
3) Be supplied with all required accessories to match the specified fixture.
4) Be supplied with all remote drivers, power supplies and cabling lengths to meet specified performance and control.
5) Provide the same or better distribution, efficiency, source lumen output, and L70 lumen depreciation metric.
b. Provide point-by point photometric calculations at the request of the Engineer for evaluation.
c. The evaluation of an approved equal shall be at the sole discretion of the Architect and Engineer.

C. Product Description: Complete interior luminaire assemblies, with features, options, and accessories as scheduled.

D. Performance requirements

1. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
2. 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. Recessed Fixtures: Comply with NEMA LE 4.
d. Bulb shape complying with ANSI C79.1.
e. Lamp base complying with ANSI C81.61.
f. CRI of minimum 80.
g. LED lamp life, minimum of 50,000 hours.
h. TM-21 L70 lumen depreciation metric calculated at color temperature listed.

i. Internal ballast/driver.
j. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

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.
4. 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.
5. Diffusers and Globes:
   a. Refer to Interior Light Fixture Schedule for types.
   b. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   c. Glass: Annealed crystal glass unless otherwise indicated.
   d. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
6. Housings:
   a. Extruded-aluminum housing and heat sink unless otherwise indicated.
   b. Powder-coat finish unless otherwise indicated, color selection by Architect.
7. 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.
   a. Label shall include the following lamp characteristics:
      1) "USE ONLY" and include specific lamp type.
      2) Lamp diameter, shape, size, wattage, and coating.
      3) CCT and CRI for all luminaires.

B. METAL FINISHES

1. 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.

2.3 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: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage minimum.

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.

2.4 FLUORESCENT BALLASTS

A. Manufacturers:
1. General Electric Co.
2. Universal Lighting Technologies.
3. Philips Electronic North America / Advance.
4. Osram Sylvania.
5. Substitutions: Section 26 04 00.

B. Product Description: Electronic ballast instant start (program start where controlled by occupancy sensors) by Certified Ballast Manufacturers, Inc. to comply with ANSI C82.1, suitable for lamps specified, with voltage to match luminaire voltage.

2.5 HIGH INTENSITY DISCHARGE (HID) BALLASTS

A. Manufacturers:
1. General Electric Co.
2. Universal Lighting Technologies.
3. Philips Electronic North America / Advance.
4. Osram Sylvania.
5. Substitutions: Section 26 04 00.

B. Product Description: ANSI C82.4, metal halide lamp ballast, suitable for lamp specified, with voltage to match luminaire voltage.

2.6 FLUORESCENT DIMMING BALLASTS AND CONTROLS

A. Manufacturers:
1. Lutron.
2. Advance Transformer.
3. Universal Lighting Technologies.
4. Substitutions: Section 26 04 00.

B. Product Description: Electrical assembly of control unit and ballast to furnish smooth dimming of fluorescent lamps.

C. Ballast: Selected by dimming system manufacturer as suitable for operation with control unit and suitable for lamp type and quantity specified for luminaire.

2.7 FLUORESCENT LAMPS

A. Manufacturers:
1. General Electric Co.
2. Philips Electronics North America.
3. Osram/Sylvania.

4. Substitutions: Section 26 04 00.

2.8 HID LAMPS

A. Manufacturers:
1. General Electric Co.
2. Philips Electronics North America.
3. Osram/Sylvania.
4. Substitutions: Section 26 04 00.

2.9 LED DRIVERS

A. Manufacturers:

1. eldoLED
2. Lutron.
3. General Electric Co.
4. Philips Electronics North America.
5. Osram/Sylvania.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: LED dimming driver.

1. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
2. Digital (DALI Low Voltage Controlled) Dimming Drivers
3. Digital Multiplex (DMX Low Voltage Controlled) Dimming Drivers

C. General:

1. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
2. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
3. Driver must limit inrush current.
   a. Base specification: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 $Amps^2$ – seconds.
   b. Preferred Specification: Meet or exceed $30mA^2s$ at 277VAC for up to 50 watts of load and 75A at 240us at 277VAC for 100 watts of load.
4. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
5. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
6. Total Harmonic Distortion less than 20% percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
7. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:

a. Adjustment of forward LED voltage, supporting 3V through 55V.
b. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
c. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.

8. Driver must be able to operate for a (+/- 10%) supply voltage of 120V through 277VAC at 60Hz.
9. Driver should be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
10. Driver shall include ability to provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.

D. Light Quality

1. Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 1 percent and 10% relative light output where indicated, or 100 – 10% light standard. Driver shall respond similarly when raising from 1% to 100%
   a. Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
2. Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.
3. Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-1 percent luminaire shall have:
   a. LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.
   b. Base specification: Flicker index shall less that 5% at all frequencies below
   c. 1000 Hz.
   d. Preferred specification: Flicker index shall be equal to incandescent, less that 1% at all frequencies below 1000 Hz.

E. Control Input

1. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
   a. Must meet IEC 60929 Annex E for General White Lighting LED drivers
   b. Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
   c. Must meet ESTA E1.3 for RGBW LED drivers
2. Digital (DALI Low Voltage Controlled) Dimming Drivers
   a. Must meet IEC 62386
3. Digital Multiplex (DMX Low Voltage Controlled) Dimming Drivers
   a. Must meet DMX / RDM: USITT DMX512A and ANSI E1.20 (Explore & Address)
   b. Capable of signal interpolation and smoothing of color and intensity transitions

F. *Driver: Selected by dimming system* manufacturer as suitable for operation with control unit and suitable for LED source type and quantity specified for luminaire.

2.10 LED FIXTURES

A. Refer to light fixture schedule.

B. Minimum allowable efficacy of 80 lumens per watt.

C. Integral junction box with conduit fittings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install suspended luminaires using pendants supports. Install pendant length required to suspend luminaire at indicated height.

1. Suspended Luminaire Support:
   a. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   b. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box, heavy-duty swivel hangers and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
   c. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
   d. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

B. Support luminaires independent of ceiling framing.

C. Where remote ballasts are required, mount ballasts in remote locations as per the manufacturers' recommendations and per ballast requirements, at no additional cost.

D. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

E. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

F. Exposed Grid Ceilings: Support surface-mounted luminaires on grid ceiling directly from building structure.

G. Install recessed luminaires to permit removal from below.

H. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

I. Install clips to secure recessed grid-supported luminaires in place.

J. Install wall-mounted luminaires at height as indicated on Drawings and as scheduled.

K. Install accessories furnished with each luminaire.

L. Connect luminaires to branch circuit using flexible conduit, except for emergency lighting which shall be in conduit completely.

M. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

N. Install specified lamps in each luminaire.

O. Ground and bond interior luminaires in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Aim and adjust luminaires as indicated on Drawings.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Remove dirt and debris from enclosures.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

3.5 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.

B. Relamp luminaires having failed lamps at Substantial Completion.

3.6 SCHEDULES

A. Refer to Drawings.

END OF SECTION

SECTION 265200 - EMERGENCY LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes emergency exit signs and egress marking systems.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SYSTEM DESCRIPTION

A. Emergency lighting to comply with requirements.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit dimensions, ratings, and performance data.

C. Samples: Submit two color chips 3 x 3 inch in. size illustrating unit finish color.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 EXTRA PRODUCTS

A. Provide (6) universal exit signs complete with all labor and materials required for installation as directed by the Local Authority Having Jurisdiction.

1.7 MAINTENANCE MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 EXIT SIGNS

A. Manufacturers:
1. Manufacturers represented by Apex Lighting.
2. Manufacturers represented by Lighting Affiliates.
3. Manufacturers represented by Reflex Lighting.

4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Exit sign fixture.

C. Housing: Extruded aluminum.

D. Face: Translucent plastic face with red letters on white background. Provide with international symbol of accessibility at level of exit, accessible exits as indicated on the Drawings.

E. Letters and Directional Arrows: Universal type for field adjustment sized so that they are clearly visible at a distance of 40 feet as required by local codes.

F. Mounting: As indicated on Drawings and universal, for field adjustment.

2.2 SELF-LUMINOUS FLOOR PROXIMITYEXIT SIGNS

A. Manufacturers:
1. Manufacturers represented by Apex Lighting.
2. Manufacturers represented by Lighting Affiliates.
3. Manufacturers represented by Reflex Lighting.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Self-luminous exit sign fixture.

C. Housing: Extruded aluminum frame mounted in molded ABS enclosure.

D. Face: aluminum stencil with red face. Provide with international symbol of accessibility at level of exit, accessible exits as indicated on the Drawings.

E. Light Source: Phosphor coated glass tubes filled with tritium gas. Rated for 20 year service life.

F. Directional Arrows: Universal type for field adjustment sized so that they are clearly visible at a distance of 40 feet as required by local codes.

G. Mounting: As indicated on Drawings, provide with required mounting accessories.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install suspended exit signs using pendants supported from swivel hangers. Install pendant length required to suspend sign at indicated height.

B. Install surface-mounted exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Install wall-mounted exit signs at height as indicated on Drawings or as directed by the Authority Having Jurisdiction.

D. Install accessories furnished with each exit sign and egress marking system component.

E. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within unit.

F. Install specified lamps in each exit sign.

G. Ground and bond exit signs in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Operate each unit after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Position exit sign directional arrows as indicated on Drawings and as directed by the Authority Having Jurisdiction.

3.4 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.

B. Relamp exit signs having failed lamps at Substantial Completion.

3.5 SCHEDULES

A. See Drawings.

END OF SECTION

SECTION 265561 - THEATRICAL LIGHTING AND CONTROLS

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

A. The intent of this specification is to define parameters for furnishing and installing a complete working system to the Owner. The theater systems supplier shall provide coordination with all associated trades to insure a proper and correct installation. The system is designed to meet specific operational requirements. Performance deviations will not be accepted.

B. This specification makes reference to the products of Strand Lighting to establish a level of quality and product support. Supply the specified product or approved equal. The project electrical engineer shall be the final authority for purposes of establishing product and service equivalence. Proposed substitutions may be submitted for approval in advance of bid. If not pre-submitted and approved by the engineer, proposed substitutions are subject to rejection at time of submittal. If proposed substitutions are rejected, the contractor shall submit drawings and supply the specified product without further delay.

C. Listing a manufacturer as acceptable does not specifically indicate that the manufacturer produces a product that meets approval for the specific conditions of this project. All products shall meet the requirements of the specification text and are subject to approval by the electrical engineer.

1.2 SUBMITTALS

A. Six (6) sets of full system submittals shall be furnished for approval within 60 days of award of Contract. Prior to fabrication of equipment, two sets shall be returned appropriately marked as the approval document.

B. Manufacturer shall provide any additional information, including equipment demonstration, as required by the engineer or specifier to verify compliance with specifications.

1.3 QUALITY ASSURANCE

A. Manufacturer shall be one who has been continuously engaged in the manufacturer of theatrical lighting and control equipment for a minimum of ten years. All dimmer and cabinet fabrication must take place in a U.S. manufacturing plant.

B. The manufacturer shall have a factory authorized stocking service center with at least one full-time service technician on staff located within 75 miles of the job site. In addition, the manufacturer shall have a toll free 24-hour hotline with a maximum response time of 20 minutes, 24 hours a day and 365 days a year. This level of support is integral to this specification and to the owner's needs and shall not be waived.

C. All equipment, where applicable standards have been established, shall be built to the standards of Underwriters Laboratories, Inc., the National Electric Code and the United States Institute for Theater Technology. Approved equipment shall be so labeled on delivery to the job site.

1.4 SYSTEM INTEGRATION

A. To ensure proper system installation, coordination of trades and initial setup and programming, the equipment shall be furnished by an approved stage systems integrator.

B. An approved systems integrator shall meet the following requirements:
1. Be a factory authorized service center for the manufacturer of the equipment
2. Have a full-time factory-trained technician who is currently certified for all products in this specification and in particular for DMX configuration.
3. Have a factory-trained project manager who will coordinate all project documentation and scheduling of deliveries and system energization.

C. At the time of bid submission, the Systems Integrator shall indicate:
1. The company name of the systems integration firm and their main phone number.
2. The personal name of the factory-authorized service technician who will configure and program the network.
3. The personal name of the project manager who will supervise the project.
4. Three installations of comparable scope installed by the systems integration firm within the past 3 years.

D. Bids submitted without this information shall be rejected.

E. The Systems Integrator shall also have responsibility for coordination with
1. Section 11 61 44 – Platform Rigging and Curtains

PART 2 PRODUCTS

2.1 PLPROFILE1 RGBW LED LUMINAIRE

A. The luminaire shall be a full spectrum color mixing luminaire employing a red, green, blue, and white LED engine. The engine shall be capable of providing tunable white color temperature matched presets as well as millions of permutations of color.

B. The luminaire shall employ One (1) LED light source engines that will not emit light in the ultra-violet (wavelengths less than 400nm for UV-A,B, or C) or the Infrared spectrum (wavelengths of more than 775 nm). Units that emit light within this spectrum shall not be accepted.

C. The LED technology employed in the luminaire shall be that of a light gathering and pre-combination technology from a smaller number of emitters. The LED shall comprise Red, Blue, Green, and White sources and combined via a light gathering system and then mixed using a TIR device to form a single output beam of uniform color.

D. The luminaire shall have a 18 degrees to 34 degrees or 24 degrees to 44 degrees (depending upon the lens tray type) manual control of a narrow to wide beam with a focus from soft to sharp with an output in excess of 2,000 lumens.

E. The luminaire shall have an integrated control system that provides local controls offering access to set up parameters, preset color temperatures, stored custom presets, and status reporting.

F. The luminaire shall have control inputs for DMX512 with input/output connectivity.

G. The PLprofile1 LED Ellipsoidal shall be a purpose-designed fixture for interior stage, studio and display lighting applications. It shall be constructed from custom aluminum extrusions and die-castings. All corners and edges shall be rounded and have no sharp edges. The finish is to be a low reflective, matt charcoal color, electrostatically applied, baked on epoxy powder coat.

H. Four stainless steel shutters shall be fitted, located at the focal point of the optical system in a spring tensioned gate assembly. The shutters will mask the beam and provide a crisp edge when inserted. Each shutter is to have a heat resistant handle with two finger holes for easy manipulation.

I. The sides of the profile luminaire shall be constructed from extruded aluminum for strength and lower weight. . Sides constructed from sheet metal shall not be accepted. Ventilation of the LED profile Luminaire shall be maximized by not less than five convection slots running the entire length of the housing with additional transverse ventilation slots top and bottom.

J. The front and rear of the LED Profile Luminaire shall be constructed from high temperature and impact resistant engineering plastic moldings for strength, and lower weight.

K. The PLprofile1 LED variable lenses shall be manufactured from high heat resistant polished borosilicate glass mounted within molded holders which move captive along a custom extrusion. The lenses are to move with a minimum of vibration and without metal-to-metal contact. The focus fastening system is via simple maintenance free screw knobs located on the bottom side of the lens tube.

L. The lenses shall be available for cleaning by means of a side hinged bottom tray held closed with a sprung 'push in' finger locking clip. The entire lens assembly shall be removable for cleaning without tools by unlocking of the hinge after operation of the locking clip.

M. The Medium 18 degrees to 34 degrees lens assembly supplied shall be interchangeable with the Wide 24 degrees to 44 degrees lens assembly quickly in this manner.

N. Tilt adjustment shall be by means of a screw lock system secured by a hand sized insulated "T" handle which also allows one hand adjustment. The yoke position shall be adjustable along the length of the fixture.

O. The Luminaire is provided with a formed steel yoke with a central hole for a 1/2 inch (M12) suspension bolt set comprising 1/2 inch set screw (M12), nut and two washers.

P. The luminaire shall conform to UL 1573 stage and studio use as well as UL 8750 LED standards and tested via ETL to conform to the aforementioned UL specifications, luminaire shall hold ETL, cETL, Ctick, and CE markings.

2.2 OVERVIEW (PL INTERCONNECT BOX)

A. The interconnect box shall be contain all of the power and data interconnectivity for the PLprofile1.

B. The PLICB (PL Interconnect Box) shall contain:
1. One (1) Power Con In (Blue) connector
2. One (1) PowerCon out (Gray) Connector
3. One(1) DMX 5 Pin XLR Female Connector
4. One (1) DMX 5 Pin XLR Male Connector

5. One (1) Multi-pin Data/Power Receptacle.

C. The PL interconnect box shall be able to be mounted:
1. between the luminaire yoke and the mounting device such as a C-Clamp, Hook Clamp, or Half Coupler,
2. to the underside of the yoke – Between the luminaire and underside of the yoke,
3. independently hung using a C-Clamp, Hook Clamp, or Half Coupler

D. The PL interconnect Box shall connect to the luminaire utilizing one(1) composite lead which will transmit both power and data to the interconnected luminaire.

2.3 PHYSICAL (LUMINAIRE)

A. PLprofile1 Led Shall not exceed 26.18 inches when the luminaire is at a zero degree angle (at 90 degrees) to the mounting structure and 15.94 inches high from the bottom of the luminaire to the top of the yoke with the PLICB installed.

B. The optical system shall consist of coated aspheric lenses.

C. PLprofile1 accessory holder shall be capable of holding external beam shaping devices such as diffusion, filters, and tophats.

D. The luminaire shall allow for a manual rotation of 360 degrees pan and 270 degrees tilt (through utilization of the sliding yoke) to provide optimum luminaire orientation at all times. Luminaires offering limited range of motion shall not be accepted.

E. The construction of the unit shall be a extruded aluminum, sheet metal and molded engineering grade plastic.

F. Weight shall not exceed 18.95 lbs. luminaire only.

2.4 PHYSICAL (PL INTERCONNECT BOX)

A. The PL Interconnect Box (PLICB) shall not exceed 1-11/16” (H) x 5-1/4” (L) x 3-1/16” (W)

B. The PLICB shall employ a mounting hole through the center of the unit to allow for a ½” (M12) bolt to pass through. The PLICB shall employ a reinforcing center sleeve.

C. The PLICB shall swivel independently of the luminaire to allow for cable management where no service loop for DMX or Power is required.

2.5 ELECTRICAL

A. Supply Voltage shall be 90-264VAC auto-ranging

B. The luminaires current draw shall not exceed 1.91 amps (120V) or 0.95 amps (240V) luminaires that do not meet these criteria shall not be accepted.

C. The light engine source shall be one (1) RGBW 120 Watt LED chip.

D. The luminaire shall be CE, C-Tick, ETL and cETL Listed.

2.6 ENVIRONMENTAL

A. Maximum operating ambient temperature shall not exceed 113 degrees Fahrenheit.

B. A variable speed cooling system shall be employed to maintain the optimal operating temperature of the luminaire.

C. Luminaires shall be low maintenance and environmentally friendly, all units shall be mercury free.

2.7 OPERATION

A. The luminaire shall have control inputs for: DMX 512a/1990 Luminaires utilizing proprietary only controls shall not be accepted.

B. DMX512 control will be via either 3 Channel, 8 or 16 bit control; control parameters for each DMX512 output shall be as follows:
   1. 8 Bit Mode (3 Channel)
      a. Intensity
      b. Preset Color Selection
      c. Timing
   2. 8 Bit Mode (9 Channel)
      a. Intensity
      b. Red
      c. Green
      d. Blue
      e. White
      f. Preset Color Selection
      g. For Future Use
      h. Timing
      i. Control
   3. 16 Bit Mode (15 Channel)
      a. Intensity - High
      b. Intensity – Low
      c. Red – High
      d. Red – Low
      e. Green – High
      f. Green - Low
      g. Blue – High
      h. Blue – Low
      i. White – High
      j. White – Low
      k. Preset Color Selection
      l. For Future Use
      m. Intensity time
      n. Color time
      o. Control

C. The luminaire shall an onboard display and controls of the following:
   1. Menu settings:
      a. Save a Preset
      b. Edit a Preset

c. Color mix
d. Fan Control
e. Settings
f. Lock Fixture
g. Enter Password
h. LED Status

2. Security and Password settings:
a. Security Settings
b. Power Up Modes
c. IR Enabled/Disable
d. Software updates
e. DMX512 Enabled

D. Security settings shall be employed on a four (4) level access. Each level shall allow the end user additional features and settings. Power limit settings, power up presets, hour reset, and password settings may be set under full access control. Security settings shall follow a four level access and noted as the following:
1. Level 0 system is locked, Menu/Esc. Key is active
2. Level 1 All keys are active setting of DMX512, Preset select, intensity
3. Level 2 Editing and Saving Presets added to Level 1 functionality
4. Level 3 All settings available on the settings screen

Units not utilizing this type of technology or any security settings shall not be accepted.

E. Access to on board presets shall be accessible from the control panel of the luminaire. Each user definable preset shall store color temperature, RGBW, and intensity settings for each of the thirty-one (31) presets. Presets shall be stored in the fixture firmware are defined as follows:
1. Preset 1 (Scratch Pad) user definable preset
2. Preset 2 (Warm White) factory preset
3. Preset 3 (Cool White) factory preset
4. Preset 4 (Daylight) factory preset
5. Preset 5-31 user definable presets

F. The luminaire shall provide power monitoring and hour logging technology. This technology employs provides:
1. Hours in Use
2. Power consumption
3. Operating temperature

This technology shall be utilized for information concerning the power consumption of the luminaire, and "on" time for the luminaire. The logging timer may be reset under secure password settings. Luminaires not utilizing hour logging technology and luminaire status will not be accepted.

2.8 DIMMING

A. The Luminaire, in sixteen bit mode, shall use 16-bit nonlinear scaling techniques for high-resolution dimming.

B. Dimming curves shall be optimized via the luminaire for smooth dimming over longer timed fades.

The Luminaire shall be digitally driven using high-speed pulse width modulations (PWM) in concert with power factor control (PFC) to ensure a smooth flicker free dim curve from 100 to 0 % and shall be imperceptible to video cameras and video related devices

2.9 WARRANTY

A. Luminaire manufacturer shall offer a three year warranty on the luminaire, LED and Interconnect box. Manufacturers not offering a minimum of a three year warranty shall not be accepted.

2.10 A21 DIMMER CABINET SPECIFICATION.

A. Overview.
1. The dimmer cabinets shall be fully digital, designed specifically for architectural and entertainment lighting applications, and shall consist of 3 or 6 or 9 dimmer module spaces, depending on cabinet size. A secondary "slave" 3, 6 or 9-module expansion cabinet shall also be available. Dimmer systems shall be ETL and cETL listed.
2. Cabinet setup and preset data shall, as standard, be fully user programmable on a per cabinet or system wide basis.

B. Mechanical.
1. The dimmer cabinet shall be a wall-mount, dead-front switchboard, substantially framed and enclosed with 16-gauge, formed steel panels. All cabinet components shall be properly treated, primed and finished in fine texture, scratch resistant powder coat paint.
2. The dimensions of the cabinets shall be as follows:
a. 3-Module: 6.5 inches deep, 25 inches high and 32 inches wide.
b. 6-Module: 6.5 inches deep, 42.5 inches high and 32 inches wide.
c. 9-Module: 6.5 inches deep, 62 inches high and 32 inches wide.
d. Expansion racks shall be the same size as racks with processors.
3. The system shall be convection cooled and fans shall not be required. Systems requiring forced air-cooling shall not be acceptable.
4. Dimmer module over-temperature sensing shall be provided, and the module will shut down until the temperature falls to within acceptable limits.

C. Installation.
1. The cabinet shall be factory pre-wired and dressed. The contractor shall provide and terminate all feed, load and control wiring on screw terminals fitted within the cabinet.
2. Cable entry for all cabinets shall be on the top right side of the cabinet. A removable service panel shall be provided.
3. All terminations and internal wiring shall be accessible via a removable front cover panel. The Processor Module shall be accessible for programming at all times.

D. Electrical.
1. The power efficiency of the dimmer cabinet shall be greater than 95% at full load.
2. The 3, 6 and 9 module cabinets shall be suitable for 60hz supplies of 120/208VAC Three Phase 4 wire + ground, or 277/480VAC Three Phase 4 wire + ground and shall contain any combination of up to 3, 6 or 9 Power Modules of the appropriate supply voltage. The 6 module cabinet shall also be suitable for 60hz supplies of 120/240VAC Single Phase 3 wire + ground.
3. Power feed terminals shall accept the following cable sizes:
a. Neutral Buss Bar - Main Lug (1) #6 AWG - 350 KCMIL, Load Lugs #14 AWG - #4 AWG.
b. Ground Buss Bar - Main Lug (1)) #6 AWG - 350 KCMIL, Load Lugs #14 AWG - #4 AWG.
c. Main Feed Terminal Block - (1) #6 AWG - 350KCMIL (per phase) 6 & 9-Space racks, (1) #6 - 2/0 AWG 3-Space rack.

d. Load Wires #24 AWG - #10 AWG.

4. Each 6 and 9 module dimmer rack shall support an optional Main breaker.
5. The dimmer cabinet shall have an internal power supply to support up to (16) 24VDC architectural control stations. A supplementary power supply shall also be available.
6. A "Panic" facility shall turn selected dimmers to full. Dimmers are selected from the rack processor. It shall also be possible to select "Panic" as follows:
   a. Via a remote maintained contact closure for Fire Alarm interface.
   b. Via remote momentary contact closures for "Panic" and "Normal" respectively.
7. The system may also be configured as a UL924 Emergency lighting system.
8. The system ground shall be made at a grounding lug in the top of the dimmer cabinet.
9. All equipment shall be ETL and cETL listed.

E. Cabinet Electronics, Physical.

1. The main dimmer control electronics shall be housed in one Rack Processor Module (RPM). The dimmer control electronics shall be completely digital without employing any digital to analog demultiplexing schemes or analog ramping circuits.
2. All rack setup and preset data shall be stored in a non-volatile manner.
3. Each Rack Processor Module shall have a back-lit LCD display with a keypad for rack setup, preset control, testing, rack status, error and diagnostics.
4. LEDs shall indicate "DMX512 Port A", "DMX512 Port B" (ShowNet), Vision.net control and Power.
5. The Rack Processor Module shall be mounted inside the dimmer rack. The RPM shall provide all necessary low voltage signal connections. The RPM shall provide the only point for contractor connection of signal cables and PANIC activation. The contractor connections shall be made with two-part plug in screw terminals (dedicated connector per input) for ease of installation.
6. All DMX512 & RS485 communication ports and remote contact input connections shall be optically isolated from all processor electronics by a minimum of 2,500V RMS isolation.
7. The Rack Processor shall have the provision to select any of a maximum of 96 outputs to be activated by the PANIC function. The PANIC function shall be activated or de-activated by one or more local or remote contact closures.

F. Rack Electronics, Control And Communications.

1. The control electronics shall provide the following control and communication inputs as standard:
   a. One optically isolated DMX512 control input.
   b. An RS485 control input for Vision.net architectural control. Vision.net is a control system comprised of architectural style panels for recording and playback of presets in individual assigned "rooms".
   c. There shall be two programmable panic inputs.
   d. One RS232 Serial programming port for remote programming using PC based configuration software.
   e. There shall be an expansion port on the processor termination board to connect the output of the processor to other A21, R21 dimming systems and Contact Relay panels for up to 96 channels of control.
2. The system shall support an optional ShowNet Ethernet input to provide an additional networked input plus processor status monitoring and configuration.

G. Rack Electronics, Features.

1. The rack electronics shall provide two levels of operator interface:
   a. A local interface that includes 6 menu keys and a bitmapped backlit LCD display to access standard system menus.
   b. Remote configuration via personal computer using RS232 or ShowNet Ethernet data links.
2. Dimmer control electronics shall have 16 bit (minimum) fade processing and a dimmer update rate better than 16 ms (60 Hz). Dimmers set to the same level shall output within +/-.5V of each other, regardless of phase or input voltage, providing the desired level is less than the phase input voltage less the dimmer insertion voltage.
3. Dimmer output levels shall be regulated for incoming line voltage variations. The regulation shall adjust for both RMS voltage and frequency changes of the incoming AC wave form. Regulation shall maintain the desired output voltage +/- .5V volt for the entire operation range (90 - 277 VAC). The regulation shall compensate for variations of the AC waveform on a dimmer-by-dimmer basis. There shall be no interaction between dimmers in the system or any other equipment. The output shall be regulated to the user programmable maximum voltage level on a dimmer-by dimmer basis between 24V and 277V for dimmer modules. The processor response time to incoming line changes shall take no more than 16 ms (60 Hz). Dimming systems that do not respond to line voltage and frequency variations shall not be acceptable.
4. The RPM shall also have the capability to support dimmers of different types and sizes that may be mixed throughout the rack. Individual dimmers may be dimmed or switched (non-dim). The individual phase control or switching of positive and negative line voltage half cycles shall not be acceptable, as the net resultant DC line current may damage or degrade line supply transformers.
5. As a standard, dimmer rack status reporting shall report the following conditions/data:
   a. Rack input line voltage per phase (IGBT modules).
   b. DMX512 Port A input fail.
   c. Phase failure (A, B and C).
   d. Dimmer temperature reporting (IGBT modules).
   e. Report dimmer load and Active Power Management status to a central control computer running Strand Lighting Dimmer.net and Vision.net Designer software (IGBT modules).
6. The control electronics shall provide the following setup functions that shall be user programmable on a per rack or system wide basis:
   a. DMX512 Port A patch.
   b. ShowNet DMX512 patch.
   c. Architectural patch for Vision.net control systems.
   d. Record Vision.net preset and preset crossfade time.
   e. Set dimmer max. voltage (IGBT modules).
   f. Set dimmer min. level (IGBT modules).
   g. Set control input priority logic.
   h. Set Active Power Management maximum current in 1 amp increments (IGBT modules).
7. The DMX512 Port A and ShowNet patching shall support a rack start address and individual dimmer patch. The architectural patch shall define the rack circuit/room/room channel relationship for Vision.net control systems.
8. The control electronics shall provide a facility to disable the output of any individual dimmer by setting the level to 0.
9. The processor shall provide an architectural Vision.net control system preset capability of 8 presets plus full ON and OFF up to the capacity of the dimmer rack and system.

10. It shall be possible to load new rack operating software via the serial connection to the dimmer rack. There shall be no requirement to turn power to the rack off during the loading of rack software. It shall be possible to load new rack operating software into the processor, regardless of the state of the program storage.
11. All IGBT dimmers shall support active power management technology that shall allow system designers to securely set limits on circuits to meet watts per square foot requirement on track lighting and other circuits requiring strict power management and to conform with energy management legislation. Once a circuit has a load limit set at commissioning the limit cannot be changed. Load monitoring and status reporting shall be available as a standard feature of Active Power Management allowing a facility to dynamically monitor and adjust lighting loads. The processor shall display the status of any dimmer that has shut down under power management control to indicate to the user that they have overloaded the setting for a specific circuit. This shall be displayed on the local processor and remotely on a suitably equipped personal computer.

2.11 A21 POWER MODULE SPECIFICATIONS.

A. Mechanical.
1. Power Modules shall be factory wired units of similar size and heavy duty metal construction, designed to be installed into the cabinet as a self contained bolt-in assembly. A plastic Power Module chassis shall not be acceptable.
2. Modules shall be finished in powder coat black paint.

B. Electrical.
1. Power connections shall be made on compression screw terminals. Control signal connections shall be made via plug-in connectors at each module chassis.
2. Load connections shall be via spring cage terminals.
3. Power Modules shall be suitable for 120V or 277V, 60Hz.
4. Each dimmer shall maintain its output RMS voltage within 2% for changes in load from 200 watts to full rated load at any point on the dimming curve.
5. The power efficiency of each power module shall be better than 97% at full load. Adequate heat sinking shall be provided.
6. Standard Module electronics shall be completely solid state using two silicon controlled rectifiers (SCR's) per dimmer in inverse parallel configuration.
7. SCR devices shall be encapsulated in an epoxy filled high impact plastic case with opto isolator, trigger SCR, steering bridge and snubber network. There shall be a minimum of 2500 volts isolation between the ac line and control lines of the SCR sub-assembly.
8. IGBT dimmer modules shall be available in Quad 1000 watt or dual 2000 watt variants.
9. Each dimmer shall be protected by thermal magnetic circuit breaker of the appropriate capacity mounted on the faceplate of the cabinet. This protective device shall have a "must trip" rating of 125% of rated capacity and be rated for a minimum 10,000 Amp interrupting capacity.
    a. It shall be possible to use the breaker as a dimmer disconnect device and shall be a UL, cUL listed.
    b. Under overload conditions, the breaker will disconnect power to the dimmer to protect the power device.
    c. The full load current shall be carried and controlled by the SCR or IGBT power device. Dimmers employing Triacs shall not be acceptable.
    d. All Power Modules shall be capable of continuous operation at full rated load. Under no circumstances will modules allowing continued operation with loads substantially in excess of the rated capacity be acceptable.

e. Each assigned Non-Dim shall have a programmable switching threshold between 1 and 99%.
f. At full load under normal operating conditions, voltage insertion loss in the dimmer shall be typically 2 volts, but shall not exceed 4 volts.
g. All dimmers shall have a local control switch to turn the dimmer on for testing and diagnostic purposes.
h. Dimmer racks shall ship with a dimmer bypass jumper installed on the load terminal blocks. This bypass jumper shall permit loads to be tested and operated from the dimmer rack circuit breakers prior to installation of the system control stations. These jumpers shall be removed at system commissioning. Systems not offering this feature shall not be accepted.
i. Each dimmer shall have a local test button to permit testing dimmer modules when they are installed without requiring access to system control stations. IGBT dimmer modules shall also feature diagnostic LED indicators for system trouble shooting.

10. Power Modules shall be ETL and cETL recognized.

C. Features.

1. Specific Features of the Incandescent/Inductive Dimmers shall be as follows:
a. Standard dimmer modules shall be available for operation on 120 or 277 volt power supplies and are offered in Quad 1000,1800 and 2000 watt (120V) and up to 4000 watt (277V) modules. Dual 1800 and 2000 watt (120V) and up to 4000 watt (277V) modules.
b. SCR Dimmers shall have an integral inductive torroidal filter designed to reduce the rate of rise of current such that the rise time shall not exceed 350µs at full load, measured between 10 - 90% of the load current waveform at a 90° conduction angle.
c. The dimmer firing circuitry shall produce an output sine wave that is fully symmetrical to minimize the dc component in the output waveform to within +/- 1 volt dc.
d. It shall be possible to dim low voltage transformer fed loads providing that the transformer used is approved by the manufacturer for use with phase control dimmers.
e. When dimming cold cathode loads with an Incandescent/Inductive Power Module, a fluorescent dimming curve shall be assigned from the Processor keypad to give a bottom set cut-off ensuring the maximum range of stable performance.

2. Specific Features of the IGBT dimmer module shall include:
a. IGBT modules shall be available in dual 2000 watt or quad 1000 watt variants.
b. Dimmer output waveform shall be available with forward or reverse phase control and effective filtering equivalent to 1000µs.
c. Each dimmer module shall offer microprocessor controlled over-current and short circuit protection and will automatically shut down in the presence of these conditions. Resetting the dimmer to zero from the control system shall restore operation in the event of a module shutdown.
d. The dimmer shall control a wide range of loads including dimmable electronic ballasts, LED's, conventional incandescent lamps. Audible noise shall be reduced through the use of electronic phase control and no chokes shall be required. Dimmer efficiency shall exceed 98%.
e. IGBT dimmer modules shall support Active Power Management technology. Each dimmer will report load status and may have a maximum load set on a per dimmer basis in one amp increments.

3. Specific features of the Fluorescent Dimmer Modules shall be as follows:
   a. Fluorescent modules are available in dual 120/277 volt power ratings suitable for dimming a wide range of loads.
   b. The fluorescent dimmers shall be suitable for dimming electronic 2 wire or 3 wire ballasts as well as 0-10VDC control ballasts as recommended by the dimming manufacturer.
   c. A mechanical relay shall be provided for switching on the cathode heater supply when the control level is raised above zero on 0-10VDC control modules.
   d. The fluorescent dimmers shall have a "Bottom Set" to adjust the cut-off point ensuring the maximum range of stable performance for both fluorescent and cold cathode loads.
4. Specific features of the Non-Dim Modules shall be as follows:
   a. Non-dim modules shall be available for 120 and 277 volt applications. Modules shall have 2 or 4 relays rated at 15 or 20 amps.
   b. Non-dims shall allow any circuit to be switched as a non-dim through substitution of a Non-Dim Module for the Dimmer.
   c. Non-dims shall be designed so that they can be used for inductive (transformer-fed) loads. Non-Dims with chokes shall not be acceptable.

D. Accessories.
1. A Main breaker shall be available for 6 and 9 module dimmer racks.
2. To supplement the internal Power Supply, a supplemental Power Supply shall be available to support up to 20 additional architectural control stations, and shall be supplied complete with an enclosure for wall mounting in the dimmer/distribution room. It shall be suitable for 90 - 277 volts AC 60 Hz supplies.

E. Documentation.
1. System riser and connection drawings shall be supplied as specified.
2. Installation Instructions shall be supplied with each A21 Cabinet.

F. Standards.
1. The dimmer cabinet assembly shall be ETL and cETL listed.

G. Environmental Specification.
1. Ambient temperature extremes: 32 - 104 degrees Fahrenheit.
2. Relative humidity: 10 - 90% non-condensing
3. General conditions: Office level cleanliness. Interior use only.

2.12 200 PLUS SERIES CONTROL CONSOLE SPECIFICATION.

A. Overview.
1. The control console shall be a microprocessor based lighting system designed specifically for the control of theatrical, television, and live performance dimming systems.

B. Channel Capacity.
1. The console shall support the processing of up to 512 total DMX512 outputs with the 12/24 console or 1024 total DMX512 outputs with the 24/48 console, arranged in either two scenes of manual potentiometers or with expanded control capacity in a single scene configuration.

2. Communication to system devices over a network shall be available utilizing the Art-Net protocol.

C. Mechanical.
1. The console shall consist of a free standing tabletop console with LED status indicators and an LCD display.
2. The control surface shall be constructed of rigid folded sheet steel and flame retardant ABS control; the control console enclosure shall be designed for table or rack mounting with removable end pieces to facilitate this.

D. Electrical.
1. The supply voltage shall be 18VDC (from power supply). The 200 Series shall be powered through the use of an independent power supply with a molded plug appropriate to the specific geographic locale of use. No internal modification to the system is required to enable operation at 100VAC, 110VAC, 220VAC or 240VAC.
2. The following data input/output connectors shall be provided:
   a. (2) DMX512 Out (5-pin XLR - Female).
   b. (1) DMX512 In (5-pin XLR - Male).
   c. (1) RJ-45 Network cable port for Art-Net communication protocol.
   d. (1) USB Port.
   e. (1) VGA Port.
3. The power supply shall be UL, cUL listed and the entire system shall be CE marked.

E. Operational Overview.
1. These consoles are manual preset desks (12/24 or 24/48) with an integrated video display port that has submaster storage, memory playback, effects storage and playback and additional advanced features specifically engineered for LEDs and moving lights.

F. Operational Features.
1. The 12/24 console shall either control 24 channels in one scene mode or 12 channels in two scenes. The 24/48 console shall either control 48 channels in one scene mode or 24 channels in two scenes.
2. The system shall be available to patch any dimmer or group of dimmers to a single channel. It shall be possible to set every dimmer with a level (0% to 100%) that shall scale the channel level proportionally.
3. Submaster Storage: capacity shall be related to channel size. The 12/24 channel console shall have 288 submaster scenes available (12 pages of 24 submasters); the 24/48 channel console shall have 1152 submaster scenes available (24 pages of 48 submasters).
4. Grand Master and Blackout Switch: the entire system output shall be mastered by this potentiometer and switch.
5. Channel Faders: in two scene mode each of the two scenes of 12 [24] control channels shall be identified by a channel number and associated potentiometers which operate over the scale of 0 to 10 (Full).
6. Mode Selector Switches: shall select fader operation between Single Scene, Two Scene, Submaster, Moving Light, LED and Memory Playback modes.
   a. In Two Scene Mode; the console shall be operated in two scene manual preset fashion.
   b. In Single mode, the console shall provide expanded channel capacity through the use of channel assignment buttons (1-48 or 49-96) utilizing all of the system potentiometers.

c. In submaster mode all of the potentiometers shall perform as fully overlapping scene masters, providing proportional control over a maximum of 288 [1152] recorded scenes (memories or cues) in 12 [24] pages.

7. Flash Switches: a "bump" button with a LED indicator associated with each channel or scene potentiometer shall be provided to flash channels or scenes to a level set by the flash level potentiometer. These switches shall be instructed to operate in a flash or solo fashion. When the console is in record mode, the switches shall be used for rapid recording the total live output into a selected submaster.
8. The console shall include a special effects package that includes the following features:
   a. Up to 12 effects stacks with 48 steps (12/24 console) or 96 steps (24/48 console).
   b. The start, stop, fade time, and running speed (step time) of each effect can be controlled individually.
   c. The fade in and fade out time of each effect is set by the FX fade time potentiometer and adjustable from instant (0) to 2 minutes.
   d. Individual steps and their contents may be inserted or deleted.
9. It shall be possible to create and edit Scenes and Effects either Live or in a Preview mode.
10. Playback Controls: playback of channels shall be provided via manual channel faders, submasters, manual scene masters, effects playback, LED mode or Moving Light mode.
   a. The Preset mode A/B manual split crossfader shall have separate incoming and outgoing preset controllers to provide a dipless crossfade between the two manual potentiometers.
   b. The submaster mode A/B manual split crossfader shall have separate incoming and outgoing preset controller to provide a dipless crossfade between sequential and/or non-sequential recorded submasters.
   c. The Time fader potentiometers shall enable timed fades between 0 (manual) and 10 minutes. Timed crossfades may be stopped, paused and continued, manually over-ridden or reversed at any time prior to fade completion.
   d. The special effects playback controls shall allow the recording of 12 effects stacks with 48 steps (12/24 console) or 96 steps (24/48 console).
11. LED Features
   a. Up to 12 LEDs can be controlled on the 12/24 console and up to 24 LEDs can be controlled on the 24/48 console. There are dedicated LED faders for Red, Green, Blue and Attribute.
   b. A maximum of 20 Playbacks (8 on the 12/24) can be recorded with each playback having a maximum of 99 steps. Each step can have an individual fade time and wait time.
   c. LEDs can be combined with Moving Lights and conventional channels and their output levels can be stored into the effects stacks.
   d. Multiple LED units can be stored together as a Group. 12 groups are available on the 12/24 and 24 groups on the 24/48.
   e. Built in shape effects are available for LED fixtures. The available shapes shall be Rainbow, Knight Rider or Chase. Parameters that shall be adjustable are number of colors, color size, speed and direction.
   f. Advanced LED playback features shall allow up to 170 LEDs to output from a Flash video file for dynamic effects.
12. Moving Light Features
   a. Up to 12 Moving Lights can be controlled on the 12/24 console and up to 24 Moving Lights can be controlled on the 24/48 console. There are dedicated Moving Light faders for Pan, Tilt, Color and one additional, assignable Moving Light parameter.

b. Auto DMX shall automatically patch all fixtures assigned starting with the first channel available for Moving Lights.
c. Pan/Tilt Invert shall allow for inverting of either or both pan and tilt functions.
d. Moving Lights can be combined with LEDs and conventional channels and their output levels can be stored into the effects stacks.
e. Multiple Moving Lights can be stored together as a Group. 12 groups are available on the 12/24 and 24 groups on the 24/48.
f. Commonly used positions, colors and gobos shall be stored as part of the Moving Light fixture library. 10 Master Focus Groups are available and each group shall have up to 10 palettes associated with it.
g. Built in shape effects are available for Moving Light fixtures. The available shapes shall be Circle, Figure 8 and Fan Function. Parameters that shall be adjustable are center pan, center tilt and radius.

13. Setup and Configuration functions for the console shall include the following functions:
a. Contrast and backlight control of the LCD display.
b. Memory Enable or Memory Lock.
14. An integral 7 row by 21 column (147 character) backlit LCD display shall be provided to access setup information plus create, preview, and modify recorded scenes and effects.
15. The console shall maintain its memory for one month without power (by internal rechargeable batteries.) The console shall distinguish between being turned off and loss of power. If switched off a series of diagnostic tests shall be run before the desk is operational. After power loss the console shall be restored to the same state, including running effects and timed fades.
16. User and field service personnel oriented diagnostic tests and an electronic fault log shall be provided.

G. Weights And Dimensions.
1. The 12/24 channel console shall be no larger than 22.4 inches W x 12.5 inches D x 3.2 inches H and shall weigh no more than 15 lbs.
2. The 24/48 channel console shall be no larger than 31.7 inches W x 12.5 inches D x 3.2 inches H and shall weigh no more than 21 lbs.

H. Operating Environment.
1. The console should be operated under general office level conditions, with a minimum of dust.
2. The maximum operating ambient temperature shall be 32 - 104 degrees Fahrenheit.
3. The relative humidity shall be 0% - 95% (non-condensing).

I. Included Furnishings.
1. Universal Power Supply (90 - 240VAC, auto-ranging).
2. Dust Cover.
3. Operation Manual.

2.13 VISION.NET CONTROL SYSTEM SPECFICATION.

A. Capacities.
1. The system shall support up to 255 rooms with a maximum of 125 control channels per room, which can be connected to an unlimited number of dimmers, relays, or DMX512 controlled equipment. The control connection between stations and to Strand dimming and relay systems shall be via standard Cat 5e cable using the Vision.net control protocol. For DMX512 applications an optional Vision.net to DMX512 module shall be available.

2. Star wiring shall be supported using any number of available 4 port Vision.net data hubs.
3. Large-scale systems consisting of multiple Vision.net networks may be linked using a Strand Lighting ShowNet Ethernet network.
4. No central processor shall be required. Systems requiring a separate processor shall not be acceptable.

B. Interconnection.
1. Each station shall be connected as an RS485 serial "daisy chain" using Belden 1583A Cat 5e cable.
2. It shall be possible to change standard control stations at any location on the data network without requiring additional wiring or alterations to the wiring specification. Touchscreen stations shall require a separate power feed to operate the station electronics.

C. Vision.net Configuration Interface.
1. The system shall support a digital communications link for station configuration and set up.
2. An RS232 programming station shall be used for connecting a Personal Computer operating Vision.net/Vision.net Design software to the data network.

D. Vision.net Designer Configuration Software.
1. Designer software shall be a graphical set up and configuration programmed designed to operate under Windows operating systems.
2. An astronomical clock shall be available on any system touchscreen capable of being programmed to any geographical location in the world. The clock shall be able to execute any number of daily, weekly or date specific events at fixed times, or offset relative to sunset and sunrise.
3. The system shall support 125 control channels per room with up to 255 rooms per system. Any number of dimmers may be assigned to a room.
4. Each room shall be capable of having any combination or quantity of control stations.
5. It shall be possible to change stations at any location by replacing it with a different station type, and modifying the systems configuration file accordingly.
6. Each room shall have 32 presets available, regardless of the number of rooms or number of channels within each room. Presets shall be selected from control stations, or shall be "played back" automatically by time clock events. Each preset shall have its own programmable fade, delay and hold time and may be linked for sequential playback in a single sequence, or using system macros a continuous loop if required.
7. Programmable delay, fade and hold times shall be available in the following increments; instant, 1 sec., 2 sec., 3 sec., 5 sec., 7 sec., 10 sec., 15 sec., 30 sec., 1 min., 5 min., 15 min., 60 min.
8. It shall be possible to allocate a name or label to every room, panel, station, preset and group in the system.
9. It shall be possible during system configuration to create macros using a "Smart" button. Smart buttons shall carry out a sequence of standard system commands. It shall be possible to program Smart buttons from any control station pushbutton, remote input or, automatically using the astronomical time clock. It shall be possible to assign any of the system commands to any station pushbutton, external device input, time clock event, or Macro step. Smart buttons shall support if - then commands to allow for extended programming flexibility.
10. In cases where an area is to be divisible for separate or combined control, it shall be possible to combine the constituent rooms either manually or with automatic partition switches. Rooms are combined using a "Room Link" touchscreen button. Rooms that

are not linked shall maintain their own presets, levels and channels. "Room Link" coordinates the selection of presets within the combined rooms from any control station within those rooms.

11. The following commands shall be programmable to any system button:
    a. Preset.
    b. Preset/Off.
    c. Toggle.
    d. Smart.
    e. Raise.
    f. Lower.
    g. Select Map.
    h. Share.
12. The system shall include an output simulation mode allowing the system designer to test all configurations prior to system installation.
13. Touchscreen configuration shall be supported with simple drag and drop tab, button, slider, sliders, and text entities.
14. Tabbed touchscreen pages may be created for:
    a. Buttons and Sliders.
    b. Palette Monitor.
    c. Web Browser.
    d. Real Time Clock.
15. Touchscreens may optionally be connected to a Strand Lighting ShowNet Ethernet network to connect to Palette series control consoles or Network control devices. In this mode of operation, it shall be possible to view console pages that display information on Cues, Submasters, Macros, Lamp Check and Channels.

E. Vision.net Control Stations.
1. The control station faceplates shall be free of visible fasteners and shall be of aesthetic appearance.
2. Station faceplates shall be fabricated of Lexan polycarbonate plastic.
3. Control stations shall be supplied in a wide selection of custom colors with white being the default standard.
4. On control stations with sliders, the sliders shall have 1.75" (45mm) travel with color keyed slider knobs.
5. Control station push buttons shall have color keyed engravable button caps with long life two color LED backlighting for active indication of a selected function or level backlighting when off or not selected.
6. Stations shall have modular construction to permit any combination of button keypads or faders up to 4 gangs. Expansion stations shall be available.
7. Keypads on all buttons stations shall be engravable. Keypads may be exchanged at any time to permit upgrading or changing engraving and keycap colors.
8. Faceplates shall be die cut to precisely match any and all fader and button combinations required. Faceplate engraving shall be an available option.
9. Faceplates and key and fader caps shall be color coordinated.
10. All control stations shall have a unique address between 1 and 255 configured at the initial system start up.
11. A Vision.net control station may consist of up to, 8 push buttons and 12 sliders for fader operation in channel control or optionally up to 12 submasters.
12. Expansion modules shall be available to expand the capacity of any stations as required in the system design.
13. Button stations shall be available with an integral IR receiver port for a remote control of any button station.

14. All button stations shall provide inputs for up to 8 occupancy sensors and photocells. A contact closure interface for remote inputs or keyswitches shall also be standard.
15. Control stations require flush mounted masonry ("ears-in") back boxes, with a minimum depth of 3.5" (90mm). Back boxes must be grounded/earthed in accordance with local wiring practices to provide a discharge path to ground for static electricity.
16. Control stations shall be supplied complete with a sub-plate, which is screwed to the flush mounting back box with the screws provided. The sub-plate allows the control station to be hinged into position and secured with hexagonal setscrews on the bottom edge of the trim ring.
17. Data line terminations shall be via a screw-terminal plug and socket to facilitate removing a control station while maintaining the continuity of the data network.

F. Vision.net Slider With Pushbutton Stations.
1. Each station shall have a MANUAL (Take Control) button, which shall give control to the manually operated channel sliders.
2. Stations shall be available with 3, 6, 9, 12 or 15 sliders plus a proportional master. It shall be possible to allocate multiple channels within a room to a single slider.
3. Channels not allocated to a slider shall either go out or remain at the previously selected preset level when MANUAL is selected according to the configuration software.
4. Sliders may also be configured in submaster mode allowing them to operate as group masters.
5. All buttons may be programmed to over write their default settings. Each button may be assigned any of the following functions:
    a. Preset.
    b. Preset/Off.
    c. Toggle.
    d. Smart.
    e. Raise.
    f. Lower.
    g. Select Map.
6. Smart button commands including room combine, cross room commands and commands to Strand Lighting Light Palette and Rack Palette controllers.
7. Each preset button shall have a push and hold record function, which will allow the current slider settings to be recorded into one of the presets available from the local pushbuttons. Fade, Hold and Delay times for these presets will remain unchanged by this record action. If desired this function may be disabled when a station is configured.

G. Vision.net Pushbutton Stations.
1. All button stations shall be fully configurable.
2. Each button may be assigned any of the following functions:
    a. Preset.
    b. Preset/Off.
    c. Toggle.
    d. Smart.
    e. Raise.
    f. Lower.
    g. Select Map.
3. Smart button commands including room combine, cross room commands and commands to Strand Lighting Light Palette and Rack Palette controllers.
4. Each station shall store all active control information at all times. No central processor shall be required.

5. All buttons shall have blue and amber backlighting LED's. LED's shall be fully programmable with high and low levels to indicate the status of a button and provide back lighting for all button legends.
6. Each station shall have programmable inputs for Photocell or occupancy sensors.

H. Remote Driver Interface/Relay Driver Interface.
1. Each Interface shall accept up to 8 momentary contact closures at their inputs.
2. In addition to Vision.net data input, the Interfaces shall require an additional 24-volt dc power supply.

I. Portable Enclosure Kits.
1. Portable Enclosure Kits shall enable standard stations to be converted to portable units. Kits shall be supplied complete with 25ft (8m) cable and mating connectors.

J. Data Cable Specification.
1. Vision.net stations Belden 1583A Cat 5 cable.
2. DMX512 Belden 9829.

K. Documentation.
1. An Operations Manual and Installation Instructions are supplied with each system. Project installation & connection drawings shall be supplied as specified.

L. Environmental Specification.
1. For all control stations and associated equipment, the following recommendations shall apply:
   a. Ambient temperature extremes: 32 - 104 Degrees Fahrenheit.
   b. Recommended ambient temperature: 64 - 77 Degrees Fahrenheit.
   c. Relative humidity: 10% - 90% non-condensing.
   d. General conditions: Office level cleanliness - Interior use only.

2.14 PIPE MOUNT OUTLET BOX SPECIFICATION.

A. General Description.
1. Pipe Mount Outlet Boxes shall consist of an extruded aluminum enclosure and cover with a minimum wall thickness of not less than .125 inches and a minimum cross section of not less than 5 inches high x 4 inches deep. Unless otherwise specified, enclosure and cover shall be furnished in a low gloss black finish. Enclosure and cover shall be inherently rustproof.
2. Pipe mount enclosure shall have provisions for an integral internal low voltage barrier.
3. Internal wiring shall be of a minimum 125 degree Celsius cross-link polyester in gauges as required by amperage of specified connectors and receptacles.
4. Internal wiring shall terminate to molded barrier terminal blocks of proper amperage, size and capacity. Terminal blocks shall be clearly marked and identified for incoming field wiring.
5. Each pipe mount enclosure shall be furnished with a minimum of two 11 gauge "Z" brackets and (2) U-bolts and hardware sized for 2 inch O.D. pipe.
6. External circuit identification shall consist of minimum 1 inch high die cut vinyl characters in the color(s) specified herein or as shown on drawings.
7. Enclosure length and circuitry of each pipe mount inlet/outlet box shall be as specified herein or as shown on drawings.
8. Pipe mount inlet/outlet box shall be UL listed and labeled for use in the United States and in Canada and marked suitable for damp locations.

2.15 SURFACE/FLUSH MOUNT OUTLET BOX SPECIFICATION.

A. General Description.

1. Surface/Flush Mount Outlet Boxes shall consist of an extruded aluminum enclosure and cover with a minimum wall thickness of not less than .125 inches and a minimum cross section of not less than 5 inches high x 4 inches deep. Unless otherwise specified, enclosure and cover shall be furnished in a low gloss black finish. Enclosure and cover shall be inherently rustproof.
2. Enclosure shall have provisions for an integral internal low voltage barrier.
3. Internal wiring shall be of a minimum 125 degree Celsius cross-link polyester in gauges as required by amperage of specified connectors and receptacles.
4. Internal wiring shall terminate to molded barrier terminal blocks of proper amperage, size and capacity. Terminal blocks shall be clearly marked and identified for incoming field wiring.
5. External circuit identification shall consist of minimum 1 inche high die cut vinyl characters in the color(s) specified herein or as shown on drawings.
6. Enclosure length and circuitry of each outlet box shall be as as shown on drawings.
7. Surface mount inlet/outlet box shall be UL listed and labeled for use in the United States and in Canada and marked suitable for damp locations.

PART 3 EXECUTION

3.1 INSTALLATION

A. It shall be the responsibility of the Systems Integrator to receive and store the necessary materials and equipment for installation of the control system. It is the intent of these specifications and plans to include everything required for proper and complete installation and operation of the system, even though every item may not be specifically mentioned. The Systems Integrator shall deliver on a timely basis to other trades any equipment that must be installed during construction.

B. The Systems Integrator shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which it is to be installed.

C. The Systems Integrator shall install all lighting control and dimming equipment in accordance with manufacturer’s approved shop drawings.

D. All branch load circuits shall be live tested before connecting the loads to the dimmer system load terminals

E. If installation of fixtures before dirty work is completed is necessary due to coordination of trades, all fixtures shall be bagged in plastic and securely sealed to prevent particulate intrusion.

F. Any fixtures found to be damaged at the time of final review by the owner’s representative shall be immediately repaired or replaced at no cost to the owner

G. At time of system energization, or immediately following, all fixtures shall be tested and aimed as directed by the engineer and owner or their designated representative.

H. The Electrical Contractor shall supply a certified and inspected personnel lift with proper fall-protection equipment at the time of fixture aiming. The access means shall be available for 4

contiguous hours with exclusive use of the space, free from any conflicting trades or noise-producing activities. The System Integrator shall aim and focus all lighting fixtures as directed by the owner's representative

3.2 MANUFACTURER'S SERVICES

A. Upon completion of the installation, including testing of load circuits, the Systems Integrator shall notify the system manufacturer that the system is available for formal checkout.

B. Notification shall be provided in writing, two weeks prior to the time factory-trained personnel are needed on the job site.

C. No power is to be applied to the system unless specifically authorized by written instructions from the manufacturer.

D. The Systems Integrator shall be liable for any return visits by the factory engineer as a result of incomplete or incorrect wiring.

E. Upon completion of the formal check-out, the factory engineer shall demonstrate operation and maintenance of the system to the owner's representatives. Training shall not exceed four working hours.

F. The Systems Integrator shall provide an additional 4-hour session of end-user training on specific programming and operation of the control system. This training shall be provided at a date after final completion of the site work and after the factory commissioning at a time to be arranged with the owner within the first six months of occupancy.

3.3 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two years from date of delivery.

B. Warranty shall cover repair or replacement of such parts determined defective upon inspection.

END OF SECTION

SECTION 265600 - EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes exterior luminaries, poles, and accessories.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 26 05 19 – Electrical Power Conductors and Cables
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 51 00 – Interior Lighting.
4. Section 33 71 19 – Electrical Underground Ducts and Handholes
5. Section 33 79 00 – Site Grounding

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C82.1 - American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.
2. ANSI C82.4 - American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).
3. ANSI O5.1 - Wood Poles, Specifications and Dimensions.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Requirements: Submittal procedures.

B. Shop Drawings: Indicate dimensions and components for each luminaire not standard Product of manufacturer.

C. Product Data: Submit dimensions, ratings, and performance data.

D. Samples: Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

1.6 COORDINATION

A. Section 01 31 00 – Project Management, Coordination, and Commissioning: Coordination and project conditions.

B. Furnish bolt templates and pole mounting accessories to provider of pole foundations.

1.7 MAINTENANCE MATERIALS

A. Section 01 77 00 - Contract Closeout: Spare parts and maintenance products.

B. Furnish two of each lamp or LED array installed.

C. Furnish two ballasts and LED drivers of each lamp type installed.

PART 2 PRODUCTS

2.1 LUMINAIRES

A. Product Description: Complete exterior luminaire assemblies, with features, options, and accessories as scheduled.

B. Refer to Section 01 60 00 - Product Requirements for product options.

C. Refer to Section 26 51 00 – LED product requirements.

2.2 FLUORESCENT BALLASTS

A. Manufacturers:
1. General Electric Co.
2. Magnetek Inc.
3. Philips Electronic North America.
4. Advance.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Suitable for lamps and environmental conditions specified, with voltage to match luminaire voltage.

2.3 LED FIXTURES AND DRIVERS

A. Refer to Light Fixture Schedule.

B. Refer to Section 26 51 00 for LED fixture and driver product requirements.

2.4 HIGH INTENSITY DISCHARGE (HID) BALLASTS

A. Manufacturers:
1. General Electric Co.
2. Magnetek Inc.
3. Philips Electronic North America.
4. Advance.
5. Holophane.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: ANSI C82.4, metal halide lamp ballast, suitable for lamp and environmental conditions specified, with voltage to match luminaire voltage.

2.5 FLUORESCENT LAMPS

A. Manufacturers:
1. General Electric Co.
2. Philips Electronics North America.
3. Osram/Sylvania.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: All lamps shall have mercury content less than 90 picograms per lumen hour.

2.6 HID LAMPS

A. Manufacturers:
1. General Electric Co.
2. Philips Electronics North America.
3. Osram/Sylvania.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: All lamps shall have mercury content less than 90 picograms per lumen hour.

2.7 METAL POLES

A. Manufacturers:
1. Refer to Light Fixture Schedule.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 31 00 - Project Management, Coordination, and Commissioning: Coordination and Project conditions.

B. Verify foundations are ready to receive fixtures.

3.2 INSTALLATION

A. Attach stem and pendent fixtures to swivel type attachment box. Provide independent seismic restraint of each fixture.

B. Install lamps in each luminaire.

C. Bond and ground luminaries, metal accessories and metal poles in accordance with Section 26 05 26.

3.3 FIELD QUALITY CONTROL

A. Section 01 77 00 - Contract Closeout: Field inspecting, testing, adjusting, and balancing.

B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

3.4 ADJUSTING

A. Section 01 77 00 - Contract Closeout: Testing, adjusting, and balancing.

B. Aim and adjust luminaries to provide illumination levels and distribution as indicated on Drawings.

3.5 CLEANING

A. Section 01 77 00 - Contract Closeout: Final cleaning.

B. Clean photometric control surfaces as recommended by manufacturer.

C. Clean finishes and touch up damage.

3.6 PROTECTION OF FINISHED WORK

A. Section 01 77 00 - Contract Closeout: Protecting finished work.

B. Re-lamp luminaries having failed lamps at Substantial Completion.

3.7 SCHEDULES

A. See Drawings.

END OF SECTION

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Wire.
2. Mechanical connectors.
3. Exothermic connections.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Division 1 Section 013329 - General LEED® Requirements
3. Division 1 Section 017419 - Waste Management and Disposal
4. Division 1 Section 018113 - LEED® Product Requirements
5. Division 1 Section 018119 - IAQ Management

1.2 REFERENCES

A. Building Industry Consulting Service International, Inc.
1. BICSI TDM Manual - Telecommunications Distribution Methods Manual.

B. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

C. Telecommunication Industry Association/Electronic Industries Alliance:
1. TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.3 SYSTEM DESCRIPTION

A. Communications grounding systems use the following elements as grounding electrodes:
1. Building grounding electrode.

B. Do not use the following elements as grounding electrodes:
1. Building plumbing system.

1.4 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 10 ohms maximum.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Requirements: Requirements for submittals.

B. Product Data: Submit data on grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

D. Manufacturer's Installation Instructions: Submit for active electrodes.

E. Manufacturer's Certificate: Certify meet or exceed specified requirements.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 77 00 - Contract Closeout: Requirements for submittals.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.7 QUALITY ASSURANCE

A. Provide grounding, surge protection and lightning protection of telecommunications system in accordance with latest version of Grounding, Bonding and Electrical Protection chapter of the BICSI TDM Manual, TIA/EIA 607, and NFPA 70.

B. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum three years experience approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.10 COORDINATION

A. Section 01 31 00 - Project Management, Coordination, and Commissioning: Requirements for coordination.

B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 WIRE

A. Material: Stranded copper.

B. Grounding Conductor: Copper conductor bare.

C. Bonding Conductor: Copper conductor bare.

2.2 MECHANICAL CONNECTORS

A. Manufacturers:
1. Copperweld, Inc.
2. Erico, Inc.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical
5. Substitutions: Section 01 60 00 - Product Requirements

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.3 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. Cadweld, Erico, Inc.
2. Copperweld, Inc.
3. ILSCO Corporation.
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical.
6. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.2 INSTALLATION

A. Install in accordance with BICSI TDM Manual, TIA/EIA 607, and NFPA 70.

B. Provide grounding/bonding for each communication rack using #4 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor. Terminate to copper communication grounding Bar in each telecommunications room.

C. Bond main telecommunications grounding system to building grounding electrode system at main electrical service entrance location with #3/0 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor.

D. Routing of grounding conductor shall be as short and direct as practical.

E. Install routing of bonding conductors with minimum number of bends and splices. Use sweeping bends.

F. Install bonding connections with listed bolts, crimp pressure connectors, clamps, or lugs.

G. Within each MDF/IDF room, provide ground bar mounted to isolating stand offs, with pre-drilled holes for accepting cable spade lugs. Each ground bus shall connect to the next with #3/0 AWG insulated green wire, and the final termination shall be at the main demarc location.

H. Position busbars near associated equipment and insulate from supports.

I. Construct busbars of copper, 4 inches x 8 inches by 1/4 inch thick with pilot holes for ground lug.

J. Bond backbone cabling at each sheath opening.

K. Ground/bond data cabinets, racks, cable trays.

L. Conduit stub/sleeves shall be installed with ground bushings and form a continuous bonded surface.

M. Install ground from each piece of equipment to grounding bar via an insulated cable no smaller than 6 AWG stranded copper wire. Install proper grounding lug on cable where connecting to racks and grounding bar.

N. Label grounding conductors and grounding bus bars in accordance with BICSI guidelines.

O. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.3 FIELD QUALITY CONTROL

A. Section 01 45 00 - Quality Control: Field inspecting, testing, adjusting, and balancing.

B. Visually inspect from each bus bar to main grounding electrode service location.

C. Test in accordance with BICSI TDM Manual, TIA/EIA 607, and NFPA 70.

D. When improper grounding is found, check entire project and correct. Perform retest.

END OF SECTION

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Equipment bases and supports.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Division 07 Section – Penetration Firestopping.
3. Section 26 05 29 - Hangers and Supports for Electrical Systems.
4. Section 27 13 43 – Communications Services Cabling.

1.2 REFERENCES

A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

B. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.

E. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum three years experience, approved by manufacturer.

1.5 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:
   1. Allied Tube & Conduit Corp.
   2. Electroline Manufacturing Company.
   3. O-Z Gedney Co.
   4. Thomas and Betts
   5. Substitutions: Section 01 60 00 - Product Requirements.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems.
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

A. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for conduit, cable tray, raceway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

D. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. PSI Link-Seal.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and

pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Obtain permission from Architect/Engineer before using powder-actuated anchors.

D. Do not drill or cut structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
1. Concrete Structural Elements: Provide precast inserts and expansion anchors.
2. Steel Structural Elements: Provide beam clamps, spring steel clips, and welded fasteners.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:
1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every floor.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.5 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install chrome plated steel escutcheons at finished surfaces.

3.6 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

3.7 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

3.8 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 270533 - CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:
1. Division 07 Section – Penetration Firestopping.
2. Section 26 05 03 - Equipment Wiring Connections.
3. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
4. Section 26 05 34 - Floor Boxes for Electrical Systems.
5. Section 26 05 36 - Cable Trays for Electrical Systems.
6. Section 27 05 26 - Grounding and Bonding for Communications Systems.
7. Section 27 05 29 - Hangers and Supports for Communications Systems.
8. Section 27 05 36 - Cable Trays for Communications Systems.
9. Section 27 05 53 - Identification for Communications Systems.
10. Section 27 13 43 – Communications Services Cabling.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.

B. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
5. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground More than 5 feet outside Foundation Wall: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.

C. Underground Within 5 feet from Foundation Wall: Provide rigid steel conduit. Provide cast metal or nonmetallic boxes.

D. In or Under Slab on Grade: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide rigid steel conduit sweeps.

E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.

F. Wet and Damp Locations: Provide rigid steel conduit, electrical metallic tubing. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.

G. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

H. Exposed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

1.4 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit for the following:
1. Liquidtight flexible metal conduit.
2. Nonmetallic conduit.
3. Nonmetallic tubing.
4. Raceway fittings.
5. Conduit bodies.
6. Surface raceway.
7. Wireway.
8. Pull and junction boxes.
9. Handholes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:
1. Record actual routing of conduits larger than 2 inch.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.8 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.

C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; all steel fittings.

2.2 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Anamet Electrical.
3. Allied Tube and Conduit.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Interlocked steel construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel, compression (damp locations), and set screw type.

2.4 SURFACE METAL RACEWAY

A. Manufacturers:
1. Hubbell Wiring Devices.
2. Thomas & Betts Corp.
3. The Wiremold Co.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. Size: as indicated on drawings.

D. Finish: Manufacturers standard finish as selected by Architect.

E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.5 OUTLET BOXES

A. Manufacturers:
1. Erico Products.
2. Raco.
3. Thomas & Betts Corp.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

D. Wall Plates for Finished Areas: As specified in Section 26 27 26.

E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.6 PULL AND JUNCTION BOXES

A. Manufacturers:
1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Hinged Enclosures: As specified in Section 26 27 16.

D. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:

1. Material: Galvanized cast iron.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

E. Concrete Composite Handholes: Die-molded, concrete composite hand holes:
1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
2. Cover: Concrete composite, weatherproof cover with nonskid finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.

B. Remove concealed abandoned raceway to its source.

C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.

D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.

E. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.

F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 26 05 26.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.

C. Identify raceway and boxes in accordance with Section 26 05 53.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.4 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in Section 26 05 29.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit under slab from point-to-point.

K. Maintain clearance between raceway and piping for maintenance purposes.

L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

M. Cut conduit square using saw or pipe cutter; de-burr cut ends.

N. Bring conduit to shoulder of fittings; fasten securely.

O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.

R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

W. Close ends and unused openings in wireway.

3.5 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights as specified in section for outlet device.

B. Coordinate communications device locations with furniture plan and receptacle locations to accommodate the intended purpose prior to rough-in.

C. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

D. Orient boxes to accommodate wiring devices oriented as specified in Section 271343.

E. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

F. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

G. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

H. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

I. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

J. Install stamped steel bridges to fasten flush mounting outlet box between studs.

K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

L. Install adjustable steel channel fasteners for hung ceiling outlet box.

M. Do not fasten boxes to ceiling support wires or other piping systems.

N. Support boxes independently of conduit.

O. Install gang box where more than one device is mounted together. Do not use sectional box.

P. Install gang box with plaster ring for single device outlets.

3.6 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 07 Section “Penetration Firestopping”.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.

C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.7 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.8 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes cable tray.

B. Related Sections:
1. Division 07 Section – Penetration Firestopping.
2. Section 27 05 26 - Grounding and Bonding for Communications Systems.
3. Section 27 05 29 - Hangers and Supports for Communications Systems.
4. Section 27 05 53 - Identification for Communications Systems.
5. Section 27 13 43 – Communications Services Cabling.

1.2 REFERENCES

A. ASTM International:
1. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. National Electrical Manufacturers Association:
1. NEMA FG 1 - Nonmetallic Cable Tray Systems.
2. NEMA VE 1 - Metal Cable Tray Systems.
3. NEMA VE 2 - Metal Cable Tray Installation Guidelines.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.

C. Product Data: Submit fittings and accessories.

D. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience, and with service facilities within 100 miles of Project.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

PART 2 PRODUCTS

2.1 METAL LADDER-TYPE CABLE TRAY

A. Manufacturers:
1. B-Line Systems.
2. Chalfant.
3. Thomas and Betts.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: NEMA VE 1, Class 20C ladder type tray.

C. Material: Aluminum.

D. Finish: Galvanized to ASTM A123/A123M; galvanize after fabrication..

E. Inside Width: 18 inches or as indicated on Drawings.

F. Inside Depth: 5 inches or indicated on Drawings.

G. Straight Section Rung Spacing: 9 inches on center.

H. Inside Radius of Fittings: 24 inches.

I. Furnish manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

2.2 WARNING SIGNS

A. Engraved Nameplates: 1/2 inch black letters on yellow laminated plastic nameplate, engraved with: WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

PART 3 EXECUTION

3.1 INSTALLATION

A. Install metal cable tray in accordance with NEMA VE 2.

B. Support trays and fasten to structure and finishes in accordance with Section 26 05 29. Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of 10 ft maximum.

C. Install expansion connectors where recommended by manufacturer or as indicated on Drawings.

D. Install firestopping in accordance with Section 07 84 00 to sustain ratings when passing cable tray through fire-rated elements.

E. Ground and bond metal cable tray in accordance with Section 26 05 26.
   1. Provide continuity between tray components.
   2. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
   3. Install 2 AWG bare copper equipment grounding conductor through entire length of tray; bond to each component.
   4. Make connections to tray using mechanical, compression or exothermic connectors.

F. Install warning signs at 50 feet centers along cable tray, located to be visible.

END OF SECTION

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Labels.
   3. Wire markers.
   4. Conduit markers.

B. Related Sections:
   1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.
   2. Section 26 05 53 - Identification for Electrical Systems.
   3. Section 27 13 43 – Communications Services Cabling.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data:
   1. Submit manufacturer’s catalog literature for each product required.
   2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept identification products on site in original containers. Inspect for damage.

C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Install labels only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
   1. Seton.
   2. Brady.
   3. Ideal Industries
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.

C. Letter Size:
   1. 1/8 inch high letters for identifying individual equipment and loads.
   2. 1/4 inch high letters for identifying grouped equipment and loads.

D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Manufacturers:
   1. Seton.
   2. Brady.
   3. Ideal Industries
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Labels: Embossed, pre-printed adhesive tape, with 3/16 inch white letters on black background.

2.3 WIRE MARKERS

A. Manufacturers:
   1. Seton.
   2. Brady.
   3. Ideal Industries
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Cloth tape or, split sleeve type wire markers.

C. Legend:
   1. Control Circuits: Control wire number as indicated on shop drawings.
   2. Work area data drop cables:

a. Coordinate with Owner's IT representative. Drops shall be labeled with room number and sequential lettering starting with "A" for all drops in room.

3. Work area voice drop cables:
   a. Coordinate with Owner's IT representative. Drops shall be labeled with room number and letter "V" and sequential numbering starting with "1" for multiple voice drops in room drops in room (ex. xxxV1, xxxV2…etc.).

2.4 CONDUIT AND RACEWAY MARKERS

A. Manufacturers:
   1. Seton.
   2. Brady.
   3. Ideal Industries
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Nameplate fastened with straps.

C. Color:
   1. Voice System: Blue lettering on white background.
   2. Data System: White lettering on black background.

D. Legend:
   1. Voice system: VOICE.
   2. Data System: TELECOMMUNICATIONS.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:
   1. Install nameplate parallel to equipment lines.
   2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
   3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
   4. Secure nameplate to equipment front using screws.
   5. Install nameplates for the following:
      a. Equipment racks and cabinets.

C. Label Installation:
   1. Labeling procedures shall meet TIA/EIA 568B Series standard and BICSI Standards and shall be pre-approved by the Architect.
   2. Permanently label, using pre-printed labels, all cables and terminations.
      a. Patch panels and cross-connect blocks, numerically from top to bottom.

b. Patch panel port with work area outlet label.
c. Cable segments.

3. Install label parallel to equipment lines.
4. Use industry standard TIA/EIA and BISCI color codes.

D. Wire Label Installation:

1. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
2. Install labels at data outlets identifying patch panel and port designation as specified.

E. Conduit Marker Installation:

1. Install conduit marker for each conduit longer than 10 feet.

2. Conduit Marker Spacing: 20 feet on center.

END OF SECTION

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Grounding.
5. Cable Management.
6. Labeling.

B. Related Requirements:
1. Refer to all other Sections of Division 27.
2. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.
3. Refer to related sections in Division 26.
4. Related drawings, Technology and Electrical.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. CTHPB Documentation Submittals: Comply with Division 01 Section “Sustainable Design Requirements” and provide the following in addition to other action submittals:

1. Product Data for Credit 5d: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit 5d: For paints and coatings, including printed statement of VOC content.
3. Product Data for Credit d8: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

4. Product Certificates for Credit d10: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
5. Certificates for Credit d13: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
6. Laboratory Test Reports for Credit b4: For composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings: For communications equipment room fittings. 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. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Certificates: For equipment frames 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. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI or equivalent on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD or equivalent, Commercial Installer, Level 2.
2. Installation Supervision: Installation shall be under the direct supervision of a certified technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Installer must be a certified technician of the manufacturer of the specified products.
4. Field Inspector: Currently registered by BICSI as RCDD or equivalent to perform the on-site inspection.
5. All installers/technicians must hold appropriate Connecticut telecommunications or trade license.

1.7 COORDINATION

A. Coordinate layout and installation as necessary with Owner, Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate as necessary with Electrical Contractor and other trades as needed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment frames shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 BACKBOARDS

A. Provided by Division 26. Refer to "E" Drawings and Division 26 for further information.

B. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."

2.3 EQUIPMENT FRAMES

A. Subject to compliance with requirements, equipment frames shall be better than or equivalent to Belden.

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch (480-mm) panel mounting.

3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Black.
5. Maintain a minimum of 3’ clearance in the front and back of the cabinets or racks.

C. Floor-Mounted Racks: Modular-type, steel construction.

1. Open frame, 7-foot high.

2. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
3. Baked-polyester powder coat finish.
4. Black.
5. Four post type.
6. Maintain a minimum of 3’ clearance in the front and back of the cabinets or racks.
   a. Better than or equivalent to Belden 4-post rack – part number XDR8419-3102836

D. Modular Wall Cabinets:

1. Wall mounting.
2. Steel construction.
3. Treated to resist corrosion.
4. Lockable front doors.
5. Louvered side panels.
6. Cable access provisions top and bottom.
7. Grounding lug.
8. Rack-mounted, 250-cfm (118-L/s) fan.
9. Power strip.
10. All cabinets keyed alike.

E. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Black.
4. Vertical cable management panels shall have front and rear channels, with covers.
5. Vertical cable managers shall be BHVL006 – 6.06” wide or equivalent and/or CPI 11374-703 (6”wide) or equivalent.
6. One 6” vertical cable manager should be used between the MDF and IDF racks.
7. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.
8. Minimum of 6 inch deep spaced every 2 feet in height apart.
9. Provide provisions to accommodate power strip at back of the vertical cable managers if possible.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.

3. Ten, 15-A, 120-V ac, NEMA 5-15P receptacles.
4. Cord Length minimum of 12 feet
5. Output: 120V Output Connections: NEMA 5-15R
6. Provide power strip at back of the vertical cable managers if possible; one per rack.
   a. Better than or equivalent to APC Model# AP9562

2.5 UN-INTERRUPTABLE POWER SUPPLIES

A. Provide one UPS for each data rack, 1200 Watts/2200VA, Input 100V/Output 100V.

B. Mount UPS at bottom of each data rack.

C. Better than or equivalent to APC Model# SMT2200RM2U

2.6 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with ANSI/TIA-607-C.

2.7 LABELING

A. Comply with TIA -606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with and follow CREC's network drop labeling specifications (See Attachment A).

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

B. Refer to "E" Drawings and Section 26 for further detail.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with as necessary with Owner and Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI/TIA-607-C.

C. Comply and refer to Section 270526, “Grounding and Bonding for Communications Systems”.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

E. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA -606-B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA -606-B for Class 3 level of administration including optional identification requirements of this standard.

D. Labels shall be preprinted or computer-printed type.

E. Comply and follow CREC's "Network Drop Labeling Specification", "Attachment A".

F. SEE ATTACHMENT A.

END OF SECTION 271100

SECTION 271300 – COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

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

C. The Telecommunications Contractor shall ensure that the General Contractor and Painting Contractor acknowledge that painting of or over spray any single or group of 4 pair horizontal telecommunications Category 5e, Category 6, Category 6A, Coaxial or Fiber Optic cable is not allowed. Any painted or over sprayed cable(s) shall be replaced at the painting contractor's expense. Painted Cable will not be covered as part of an extended warranty. Painted cable in addition to obscuring the print legend may act as an accelerant or create an additional smoke hazard in the event of a fire and as such this is considered a life safety issue.

D. Technology Drawings.

E. "E" Drawings, including riser diagrams and details, Division 26 and any other divisions referenced on the drawings or written specifications.

F. Refer to Section 0 for business set aside information.

1.2 SUMMARY

A. This Section includes the following:

1. Pathways
2. 50/125-micrometer, optical fiber cabling
3. Coaxial Cable Coordination (CATV extended to MDF only, not distributed to classrooms)
4. Cable connecting hardware, patch panel and cross-connects
5. Cabling identification products
6. 25-pair Copper Cable

B. Related Sections:

1. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

C. There will be a 24-pair multimode fiber backbone from IDFs to MDFs along with a 12-pair single mode fiber backbone from IDFs to MDF. Additionally, there will be a 25-pair copper backbone from IDFs to MDF (where the demark is located) punched down into 110 blocks on the wall-field in a vicinity that makes sense for future cross-connects from 110-blocks to patch panels in the data racks.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA -568-C.1, when tested according to test procedures of this standard.

1.6 ACTION SUBMITTALS

A. CTHPB Documentation Submittals: Comply with Division 01 Section “Sustainable Design Requirements” and provide the following in addition to other action submittals:

1. Product Data for Credit 5d: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit 5d: For paints and coatings, including printed statement of VOC content.
3. Product Data for Credit d8: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
4. Product Certificates for Credit d10: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

5. Certificates for Credit d13: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
6. Laboratory Test Reports for Credit b4: For composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. For coaxial cable, include the following installation data for each type used:
   a. Nominal OD.
   b. Minimum bending radius
   c. Maximum pulling tension

C. Provide contractor’s proof of factory certification at time of bid.

D. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:

   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to side of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.8 CLOSEOUT SUBMITTALS

A. Complete system documentation including test results and patch panel layout information. Provide (1) hard copy and one (1) electronic copy in Microsoft Excel or Microsoft Word format.

B. 25-year warranty in writing from a single manufacturer such as Belden Partner Alliance Program or Mohawk Accredited Contractor (MAC) program; for the installed cabling system. The warranty shall cover the complete system, including but not limited to the fiber optic backbone, its termination hardware including but not limited to patch panels and jacks and the horizontal cabling system it's connected to and the horizontal cabling system's termination hardware.

1.9 MAINTENANCE MATERIALS 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. Fiber Patch Cords: One of each type.

1.10 QUALITY ASSURANCE

A. Installer Qualifications:

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD or equivalent.
2. Installation Supervision: Installation shall be under the direct supervision of a certified technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Installer must be a certified technician of the manufacturer of the specific products.
4. All installers/technicians must hold appropriate Connecticut telecommunications or trade license.

B. Testing Agency Qualifications: A Nationally Recognized Test Laboratory "NRTL".

1. Testing Agency's Field Supervisor: Currently certified by BICSI or equivalent as RCDD to supervise on-site testing.

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.

D. Telecommunications Pathways and Spaces: Comply with ANSI/TIA -569-D and requirements in Section 270528, "Pathways for Communication Systems".

E. Grounding: Comply with ANSI/TIA-607-C and Section 270526 "Grounding and Bonding for Communication Systems".

1.11 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 loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.12 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install 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.

1.13 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate as necessary with Electrical Contractor and other trades as needed.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with ANSI/TIA -569-D.

B. Refer to Section 270528, “Pathways for Communication Systems”.

C. Cable Support: NRTL labeled for support of 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.
3. Straps and other devices.

D. Cable Trays:

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. Better or equivalent to Belden

2. Coordination: Although closet detail is included on the E drawings showing cable tray layouts, the Contractor shall coordinate final cable tray installation so that trays and lighting and air conditioning units to not conflict with each other.

3. Also Refer to Section 270536 “Cable Trays for Communication Systems”.

E. 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 (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 BACKBOARDS

A. Provided by Division 26. Refer to “E” Drawing and Division 26 for further information.

B. Backboards: Plywood, fire-retardant treated. Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.3 OPTICAL FIBER CABLE – The fiber optic backbone will consist of a 24-strand multimode backbone and a 12-strand single mode backbone. Fiber Optic cable shall be better than or equivalent to Belden.

A. Description: Multimode, 50/125-micrometer, OM3 or OM4 (as appropriate for locations indicated on the drawings), 24-fiber,tight buffer, optical fiber cable. Plenum rated.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA -568-C.3 for performance specifications.
3. Comply with TIA -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, Nonconductive: Type OFN or OFNG, or OFNR, OFNP.
    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    c. Riser Rated, Nonconductive: Type OFNR or OFNP, complying with UL 1666.
    d. General Purpose, Conductive: Type OFC or OFCG; or OFNG, OFN, OFCR, OFNR, OFCP, or OFNP.
    e. Plenum Rated, Conductive: Type OFCP or OFNP, complying with NFPA 262.
    f. Riser Rated, Conductive: Type OFCR; or OFNR, OFCP, or OFNP, complying with UL 1666.
5. Maximum Attenuation:
    a. OM3 3.25 dB/km at 850 nm; 1.2 dB/km at 1300 nm.
    b. OM4 3.0 dB/km at 850 nm; 1.0 at 1300 nm.
6. Minimum Modal Bandwidth:
    a. OM3 2000 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
    b. OM4 4700 MHz at 850 nm; 500 MHz at 1300 nm.

B. Description: Single mode, OS2, 12-fiber, tight buffer, optical fiber cable. Indoor/Outdoor riser, plenum rated. 12-strand fiber shall be used as single mode backbone from IDFs to MDF.

C. Jacket:
1. Cable cordage jacket, fiber, unit, and group color shall be according to TIA -598-B.
2. Printed with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.4 OPTICAL FIBER CABLE HARDWARE

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. Better or equivalent to Belden

B. Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions for adequate expansion.

C. Patch Cords: Factory-made by fiber connector manufacturer, dual-fiber cables in 1 and 3 meter lengths (half 1 meter the other half 3 meter).
1. Provide one patch cord per 48 RJ45 data ports, plus 20%.
2. Provide LC-LC connectors.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA -604-2, TIA -604-3-A, and TIA -604-12. Comply with TIA -568.3-D.
2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.50 dB.
3. Type LC connectors may be used in termination racks, panels, and equipment packages.

2.5 COAXIAL CABLE. There will not be distributed coaxial cable; however, the contractor shall carry an appropriate allowance to provide materials and installation to extend the Cable TV service to the MDF if necessary and will provide coordination with the Cable TV provider.

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. Better or equivalent to Belden

B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG59/U: NFPA 70, Type CATV.

1. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
3. PVC jacket.

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV or CATVP.
2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Riser Rated: Type CATVR or CATVP, complying with UL 1666.

2.6 COAXIAL CABLE HARDWARE

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. Better or equivalent to Belden

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.7 TWISTED COPPER CABLING. There shall be installed a 25-pair copper backbone from each of the IDFs to the MDF, terminated/punched down on 110 blocks on the wall fields within the data closets. The Telecommunications Contractor shall provide services and materials to install cross-connections as needed from 110 blocks to Patch Panels for requirements such as analog phone line locations.

A. Better than or equivalent to Mohawk 25-pair copper cable M58141 CMR or M58142 CMP

B. Belden 25 pair copper cable IBDN25R 0081000 CMR or IBDN25P 0081000 CMP.

2.8 TWISTED COPPER HARDWARE

A. 110 Blocks
   1. Better or equivalent to Belden
   2. Installation of 110 Blocks on the wall field should be installed in proximity to data racks and cable trays to plan and coordinate for future patching from 110 blocks to patch panels in data racks.

B. Provide patch panels in data racks to accommodate cross-connections from 110 blocks.

2.9 GROUNDING

A. Refer to “E” Drawings and Division 26 documents for Grounding and Bonding instructions.

B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

C. Comply with requirements in Section 270526 “Grounding and Bonding for Communications Systems”.

D. Comply with ANSI/TIA-607-C.

2.10 IDENTIFICATION PRODUCTS

A. Comply with ANSI/TIA -606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with CREC network labeling requirements in “Attachment A” of Section 271100.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to ANSI/TIA -568-C.1.

C. Factory test multimode optical fiber cables according to ANSI/TIA -526-14-A and ANSI/TIA -568-C.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider and Division 26.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA -569-D.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with ANSI/TIA -569-D for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where 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 when entering room from overhead.
4. Extend conduits 3 inches (76 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with ANSI/TIA -568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
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 ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. 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.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. Optical Fiber Cable Installation:

1. Comply with ANSI/TIA -568-C.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. 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 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.

F. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).

G. Group connecting hardware for cables into separate logical fields.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and ANSI/TIA -569-D 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 nonmetallic 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 (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

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 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

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 (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with ANSI/TIA -569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI /TIA-607-C.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA -606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: 3.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with ANSI/TIA -606-B for Class 2 level of administration.

D. Comply with requirements in Section 271500 "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA 606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with ANSI/TIA/EIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper 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 cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA -568-C.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 ANSI/TIA -568.3-D. 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) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to ANSI/TIA -526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in ANSI/TIA -568-C.1.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section “Summary”, Paragraph 1.1A, and “Related Documents.”

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

C. The Telecommunications Contractor shall ensure that the General Contractor and Painting Contractor acknowledge that painting of or over spray any single or group of 4 pair horizontal telecommunications Category 6, Category 6A or Coaxial cable is not allowed. Any painted or over sprayed cable(s) shall be replaced at the painting contractor’s expense. Painted Cable will not be covered as part of an extended warranty. Painted cable in addition to obscuring the print legend may act as an accelerant or create an additional smoke hazard in the event of a fire and as such this is considered a life safety issue.

D. Technology Drawings.

E. “E” Drawings, Division 26 and any other Divisions referenced on the drawings or written specifications.

F. Refer to Division 0 for business set aside requirements.

1.2 SUMMARY

A. Section Includes:

1. Category 6 and Category 6A UTP cabling.
2. Coaxial cable (minimal).
3. 50/125-micrometer, optical fiber cabling
4. Cable connecting hardware, patch panels and cross-connects.
5. Telecommunications outlet/connectors.
6. Cabling system identification products.
7. Cat 6, Cat6a Patch Cords will not be requested herein and shall be provided by others.

B. Related Requirements:

1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.
3. Section 270528 “Pathways for Communications Systems.”
4. Comply with requirements in Section 270536 “Cable Trays for Communications Systems.”

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

H. RCDD: Registered Communications Distribution Designer.

I. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

C. At the time of bid, the contractor must be certified by the manufacturer of the specified products and must be able to provide a minimum of a 25 year warranty fulfilled by the manufacturer.

D. The contractor must not only adhere to the specific requirements of the installation project as described herein and on the drawings, but must also adhere to industry standard.

E. The contractor must provide the highest quality craftsmanship that will result in a clean, well-documented and easy-to-manage cabling system.

F. The contractor shall avoid interference with other building systems, including but not limited to HVAC, sprinkler systems, fire alarm systems, etc., by attaching cable bundles directly to the building structure.

G. The contractor must comply with all local, state and National Electrical Codes.

H. The contractor is responsible for referring to and cross-referencing bid documents including but not limited to “E” Drawings, Division 26 and any other Divisions referenced on the drawings or written specifications. If the contractor finds or suspects any items that may be contradictory, the contractor shall issue an RFI for clarification. This applies throughout the duration of the project.

1.5 ACTION SUBMITTALS

A. CTHPB Documentation Submittals: Comply with Division 01 Section “Sustainable Design Requirements” and provide the following in addition to other action submittals:

1. Product Data for Credit 5d: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit 5d: For paints and coatings, including printed statement of VOC content.
3. Product Data for Credit d8: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
4. Product Certificates for Credit d10: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
5. Certificates for Credit d13: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
6. Laboratory Test Reports for Credit b4: For composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Product Data: For each type of product.

C. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:
    a. Patch panels.
    b. Patch cords.
    c. Work station outlet jacks.
    d. Horizontal and backbone cable at both ends of the installed length.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Complete system documentation including test results and patch panel layout information. Provide one (1) hard copy and one (1) electronic copy in Microsoft Excel or Word format. System documentation should include a spreadsheet/table for each data closet containing room and jack locations and labels. System documentation shall also include a final set of as-builts.

B. 25-year warranty in writing from a single manufacturer such as Belden Partner Alliance Program or Mohawk Accredited Contractor (MAC) program, for the installed cabling system. The warranty shall cover the complete system, including but not limited to its backbone and termination hardware such as patch panels, jacks, etc.

1.8 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. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.
3. Device Plates: One of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI or equivalent on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD or equivalent.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD or equivalent to supervise on-site testing.

B. Testing Agency Qualifications: A Nationally Recognized Test Laboratory (NRTL).

1. Testing Agency's Field Supervisor: Currently certified by BICSI or equivalent as an RCDD to supervise on-site testing.

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.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Submit Lot Test data for each lot of - pair of UTP cable. Lot numbers are identified on cable packaging label.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the MDF and IDFs. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. ANSI/TIA -568-C.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in ANSI/TIA -568-C.1 for Category 6A and Category 6 as applicable when tested according to test procedures of this standard.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended location and application.

C. Grounding: Comply with ANSI/TIA-607-C.

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.4 CAT 6 and CAT 6a UTP CABLE

A. Manufacturers: Subject to compliance with requirements, UTP Cable shall be better than or equivalent to the following:
1. Cat 6a UTP Cable shall be: Belden Inc. 10GXS CMP
   a. Yellow 10GXS13004A1000 for all Wireless Access Point locations
2. Cat 6 UTP Cable shall be: Belden Inc. 2413
   a. Blue 2413 D15U1000 (for all data locations except camera and voice/VOIP)
   b. Black 2413 010U1000 for all voice/VOIP data locations

c. Green 2413 005U1000 for all Camera locations in the building and mounted on the exterior of the building.

B. Description: 100-ohm, four-pair UTP CMP, covered with a Blue for data and White for voice thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with ANSI/TIA -568.1-D for performance specifications.
3. Comply with ANSI/TIA -568-C.2, Category 6A and Category 6 as applicable.
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 or MPP, complying with NFPA 262.
b. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.

2.5 CAT 6a UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, cable hardware shall be better than or equivalent to Belden Inc..

B. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA -568-C.2, IDC type, with modules designed for punch-down caps or tools. Jacks shall employ a strain relief bar securing the pairs mounted at the base of the jack. Optionally work station outlets may be terminated into REVConnect jacks of the appropriate Category 6A or 6 as applicable. Cables shall be terminated with connecting hardware of same Category 6A or Category 6 as appropriate. For the Wireless Access Point locations (WAP) as shown on the drawings, i.e., terminate both cables with REVConnect, to the core. At the WAP location, put a plug on one of the two jacks and leave the other cable tagged and bagged with the core on it. Provide the owner with plugs for the second WAP locations. Jack color shall be Yellow for WAPs, Blue for all data locations EXCEPT camera and VOIP, Black for VOIP, Green for cameras.

1. Belden KeyConnect Blue AX104156; Black AX102283; Green AX102287
2. Belden Optional REVConnect Blue RVAMJKUBL-B24 (Bulk), Black RVAMJKUBK-B24 (Bulk), Green RVAMJKUGN-B24
3. For Wireless Access Point (WAP) device connections Belden RevConnect Plug RVAFPUBK-B24 (Bulk) is acceptable.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables and shall employ a strain relief bar securing the pairs mounted at the base of the jack.

1. Category 6A
   a. Belden AX103254 24 Port 1U Pre-loaded, AX103256 48 Port 2U Pre-loaded
   b. Optional Belden REVConnect RVAPPF1U24BK 24 Port 1U Pre-loaded, RFVAPP2U48BK 48 Port 2U Pre-loaded

2. Category 6
   a. Belden AX103253 24 Port 1U Pre-loaded, AX103255 48 Port 2U Pre-loaded
   b. Optional Belden REVConnect RV6PPF1U24BK 24 Port 1U Pre-loaded, RV6PP2U48BK 48 Port 2U Pre-loaded

3. Number of Jacks per Field: One for each four-pair UTP cable indicated.

D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

E. Patch Cords: not required.

2.6 OPTICAL FIBER CABLE

A. Better than or equivalent to:

a. Belden OM3 Non Armored P/N FD3D024P9
b. Belden OM4 Non Armored P/N FD4D024P9
c. Belden OM3 Armored P/N FD3D024A9
d. Belden OM4 Armored P/N FD4D024A9

B. Description: Multimode, 50/125-micron, OM3 supporting 10G up to 300m (984 feet) or OM4 suporting 10G up to 400m (1312 feet) (as appropriate for locations indicated on the drawings), 24-fiber, tight buffer, optical fiber cable. Indoor/Outdoor riser, plenum rated. Indoor outdoor cables have Black UV and moisture resistant jackets.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA -568-C.3 for performance specifications.
3. Comply with TIA -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. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
b. Riser Rated, Nonconductive: Type OFNR or OFNP, complying with UL 1666.
c. Plenum Rated, Conductive: Type OFCP or OFNP, complying with NFPA 262.
d. Riser Rated, Conductive: Type OFCR; or OFNR, OFCP, or OFNP, complying with UL 1666.

5. Conductive cable shall be aluminum armored type.
6. Maximum Attenuation:
   a. OM3 3.25 dB/km at 850 nm; 1.2 dB/km at 1300 nm.
   b. OM4 3.0 dB/km at 850 nm; 1.0 at 1300 nm.
7. Minimum Modal Bandwidth:
   a. OM3 2000 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
   b. OM4 4700 MHz at 850 nm; 500 MHz at 1300 nm.

C. Jacket:
1. Cable cordage jacket, fiber, unit, and group color shall be according to TIA -598-B.
2. Printed with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.7 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, the fiber optical cable shall be better or equivalent to Belden Inc.

1. Belden P/N ECX-01U for 2 splice cassettes or frames, total of 24 fibers per cassettes or frame
2. Belden P/N ECX-02U for 4 splice cassettes or frames, total of 24 fibers per cassettes or frame
3. Belden P/N FC3X12LDFS OM3 splice cassette 12 LC Duplex (24 fibers)
4. Belden P/N FC4X12LDFS OM4 splice cassette 12 LC Duplex (24 fibers)
5. Belden P/N FF3X12LD OM3 FX ECX Frame/Adapter Strips
6. Belden P/N FF4X12LD OM4 FX ECX Frame/Adapter Strips

B. Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions for adequate expansion.

C. Patch Cords: Factory-made by fiber connector manufacturer, dual-fiber cables in 1 meter lengths or as needed, depending on the proposed solution.
1. Provide one patch cord per fiber ports plus 20%.
2. Provide LC-LC connectors
3. Better than or equivalent to:
   a. Belden OM3 FP3LDLD00XM; Standard lengths (X) in meters 2; 3 and 5
   b. Belden OM4 FP4LDLD00XM; Standard lengths (X) in meters 2; 3 and 5

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA -604-2, TIA -604-3-A, and TIA -604-12. Comply with TIA -568.3-D.
2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.50 dB.
3. Type LC connectors may be used in termination racks, panels, and equipment packages.

2.8 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, coaxial cable shall be better than or equivalent to Belden Inc.

B. Provide option to extend Cable TV Demark service within MDF if required. Coordinate Cable Service installation and termination with owner’s service suppliers as necessary.

C. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

D. RG-6/U: NFPA 70, Type CATV Plenum or CATVP, equivalent to or better than Belden 9116P.

1. No. 18 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Jacketed with black PVC.
4. Suitable for indoor installations.

E. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Plenum Rated: Type CATVP, complying with NFPA 262.

2.9 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, coaxial cable hardware shall be better than or equivalent to Belden Inc.

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.10 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA -568-C.1.

B. Workstation Outlets: Six-port-connector assemblies mounted in single faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks with flat face plate.
4. Legend: Machine printed, in the field, using adhesive-tape label.
5. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

C. Analog Phone Jacks shall be white colored RJ11, as designated on the drawings. *Note: a Voice Over IP phone system will be installed by the owner. All phone jacks are RJ45 unless otherwise noted.*

2.11 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with ANSI/TIA-607-C.

2.12 IDENTIFICATION PRODUCTS

A. Comply with ANSI/TIA -606-C and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

C. Follow requirements in **CREC network drop label specifications**, Attachment A in Section 271100.

2.13 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Provide factory Lot test data for UTP and optical fiber cables on reels according to ANSI/TIA -568-C.1.

C. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

B. The demark shall be established in the MDF/Server Room where all services shall enter the building and be distributed from.

3.2 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 WALL PLATES

A. Install wall plates, matching wall plates provided in specification section 262726, “Wiring Devices.”

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with ANSI/TIA -568.1-D.
2. Comply with BICSI ITSIM, Ch. 6A, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
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 ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
8. 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.
9. Cold-Weather Installation: Bring cable to room temperature 48 hours before de-reeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- (3-m-) long service loop stored in a figure 8 pattern on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch., "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with ANSI/TIA -568-C.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wire way or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports such as J-Hooks not more than 60 inches (1524 mm) apart. Supports shall be randomized between 48 and 60 inches to reduce harmonic effects due to periodicity of support spacing.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and ANSI/TIA-569-D 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 nonmetallic 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 (127 mm).
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

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 2-1/2 inches (64 mm).
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

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 (76 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with ANSI/TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI/TIA-607-C.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

E. Comply with “Grounding and Bonding for Communications Systems” Section 270526.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA -606-C. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: 3.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with ANSI/TIA -606-C for Class 2 level of administration, including optional identification requirements of this standard.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables and entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA -606-C. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Data port numbers for labeling shall start from left to right in a sequential clock-wise order ending with ceiling (WAP) locations in all classrooms, etc. For example, as one enters a classroom, the first data jack

on the left will start with 1 and given there are 9 data jacks on the classroom, the last data location would be the WAP locations in the ceiling, 8 and 9.

I. Refer to owner's labeling documentation for further labeling instructions, Attachment A in Section 271100.

J. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA -606-B.

1. Cables use flexible vinyl or polyester that flex as cables are bent. Acceptable style such as Belden LabelFLEX.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency or cabling contractor to perform tests and inspections.

B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

C. End-to-end cabling will be considered defective if it does not pass ANSI/TIA-568-C.2 Category 6A or Category 6 as applicable test limits and inspections. Category 6A Alien crosstalk measurements are not required.

D. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

END OF SECTION 271500

SECTION 275116 - PUBLIC ADDRESS AND MASS NOTIFICATION 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.

B. Section 019113-General Commissioning Requirements.

C. Technology Drawings.

D. “E” Drawings and Division 26.

E. Section 275313 "Clock Systems"

1.2 SUMMARY

A. Section Includes:

1. Central Control sound system
2. Volume limiter/compressors
3. Speakers
4. Loud Speakers
5. Preamplifiers
6. Power amplifiers
7. Local Sound Systems
8. Microphones
9. Wireless microphone systems
10. Equipment cabinet
11. Equipment rack
12. Telephone paging adapters
13. Assisted listening
14. Noise-operated gain controllers
15. Battery backup power unit
16. Conductors and cables
17. UPSs

B. Description of Scope of Work

1. Contractor shall furnish and install a complete school wide Public Address System hereafter referred to as “Sound System”, including central control sound rack, loudspeakers, wiring, conduit, supports, boxes, equipment and accessories shown on the Drawings and as specified herein and as required to provide a complete system including but not limited to:

a. Administrative display phones, programming consoles. Provide two (2).

b. Provide one stand alone programming console in the main office and one in the MDF; in-

clude direct 4 conductor run separate from the network in the event that the network goes down, announcements may still be made.

c. Classroom speaker(s), ceiling- or wall-mounted as indicated on the drawings.
d. Call initiation switches capable of placing normal, urgent or emergency calls.
e. Built in Master Clock with one thousand twenty-four (1024) events, thirty-two (32) Schedules, including Daylight Savings Time, and thirty-two (32) custom holiday events that can be assigned to any of the sixty-four (64) multi-purpose zones.
f. Wall-mounted paging horns, including exterior paging horns.
g. One (1) built-in network interface port for system combining and LAN station-to-station calling and WAN access for district-wide all-calls and remote management.
h. One (1) built-in network interface port for first-time system configuration.
i. Built-in Web Server for full system programming with Quantum Commander.
j. Administrative Web-Browser Application for Programming and Day to Day System Operation.

2. Contractor shall furnish and install a complete local sound systems in the cafeteria. The local sound systems shall be interconnected with the main sound system described above, which shall be capable of overriding any local system for announcements made to areas covered by the local sound systems irrespective of whether the local systems are “ON” or “OFF”. The same shall apply to override of fire alarm.

3. Contractor shall furnish and install complete local sound systems for classroom amplification in all classrooms and rooms where there is a SmartBoard/Interactive Board and LCD Projector as indicated on the drawings. The local sound system shall provide a solution for taechers to utilize the overhead paging speakers to deliver sound to from their classroom computers and LCD Projectors providing an integrated sound system in all classrooms. The local sound systems shall be interconnected with the main sound system described above, which shall be capable of overriding any local systems for announcements made to area covered by the local sound systems irrespective of whether the local systems are “ON” or “OFF”. The same shall apply to override of fire alarm.
   a. Classroom local sound/speakers shall be free of noise and distortion during operation and when in standby mode, including “humming” and “buzzing”.

4. This described sound system shall integrate with the Voice Over IP Phone System within the school for complete access to this system from any handset part of the VOIP system. System can connect to the PSTN (Public Switched Telephone Network) by connecting it to analog CO trunks. The Contractor shall furnish and install necessary cables, ports and connections in order to provide a fully integrated solution. The Contractor shall coordinate as required with the Owner and the Owner’s service provider of the VOIP system.
   a. Separate handsets dedicated to the sound system shall not be used in classrooms or other areas for communication back to the main office. The system shall use the owner’s VOIP handsets. Handsets/Administrative Sets shall be provided as necessary in the main office at the Reception desk.

5. The Contractor shall propose, furnish, install and adjust as necessary speakers that provide ample sound coverage to the designated areas. The Contractor may propose alternate speakers other than specified suggestions herein. It is the Contractors responsibility to provide a solution and system that provides proper sound coverage.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. VU: Volume unit.

C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Supports and seismic restraints for control consoles, equipment cabinets and racks, and components 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 ACTION SUBMITTALS

A. CTHPB Documentation Submittals: Comply with Division 01 Section “Sustainable Design Requirements” and provide the following in addition to other action submittals:

1. Product Data for Credit 5d: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit 5d: For paints and coatings, including printed statement of VOC content.
3. Product Data for Credit d8: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
4. Product Certificates for Credit d10: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
5. Certificates for Credit d13: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
6. Laboratory Test Reports for Credit b4: For composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

C. Shop Drawings: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
2. Console layouts.
3. Control panels.
4. Calculations: For sizing backup battery.
5. Wiring Diagrams: For power, signal, and control wiring.

    a. Identify terminals to facilitate installation, operation, and maintenance.
    b. Single-line diagram showing interconnection of components.
    c. Cabling diagram showing cable routing.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For qualified Installer and testing agency.

C. Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, 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. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For public address and mass notification systems to include in emergency, operation, and maintenance manuals.

1.8 MATERIALS MAINTENANCE 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. Microphone: One.
2. Desk Stand(s): One.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Personnel certified by NICET as Audio Systems Level III Technician.

B. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.

1. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.

C. Source Limitations: Obtain public address and mass notification systems from single source from single manufacturer.

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.

1.10 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. The Approved and standardized manufacturer for Public Address sound systems is the Bogen Quantum system.
2. The system shall be better than or equivalent to Bogen and shall provide a comprehensive communication network between administrive areas and staff locations throughout the facility and exterior areas of the facility. Non-volatile memory shall store permanent memory and field-programmable memory. A system, which uses a battery to maintain system configuration information shall not be acceptable.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. The system shall provide no less than the following features and functions:

1. Selectively connect any zone to any available signal channel.
2. Selectively control sound from microphone outlets and other inputs.
3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of nonuniform coverage of amplified sound.+

7. Communicating simultaneously with all other stations by actuating a single all-call switch.
8. Communicating with individual stations in privacy.
9. Communicating hands free.

B. Master Station:

1. Communicating selectively with other master and speaker-microphone stations by actuating selector switches.
2. Communicating simultaneously with all other stations by actuating a single all-call switch.
3. Communicating with individual stations in privacy.
4. Accessing separate paging speakers or groups of paging speakers by actuating selector switches.
5. Overriding any conversation by a designated master station.

C. Speaker-Microphone Station:

1. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
2. Communicating hands free.
3. Calling master station by actuating call switch.
4. Returning a busy signal to indicate that station is already in use.
5. Being free of noise and distortion during operation and when in standby mode.

D. Speakers: Free of noise and distortion during operation and when in standby mode.

2.3 FUNCTIONAL DESCRIPTION OF TELEPHONE/INTERCOMMUNICATION SYSTEMS

A. Integrated central system with the following:

1. Direct-dial, full duplex private telephone communications between all locations equipped with telephones. Call initiation among master stations and between master and remote stations by dialing station's number on a 12-digit keypad.
2. 16 channels for unrestricted simultaneous communications.
3. Initial system operation with master and remote stations, expandable to 360 stations.
4. Direct-dial, two-way amplified voice intercommunication between master telephones and remote stations without use of press-to-talk or talk-listen switches.
5. Call transfer among master stations.
6. User-selectable facility for providing selected telephones with dial tone.
7. User-selectable facility for permitting linkage of selected stations to media retrieval center and for permitting on- and off-premise computer linkage.
8. Assignment of speaker locations within any one or more of eight zones for zone paging or time signal reception.
9. Digital readout displays on which up to three incoming calls are displayed with additional calls stored for subsequent display.
10. Off-site diagnostics through a serial data port on central-control station.
11. Operation and correction of secondary clocks and control of class-change signals to speakers and bells by using keypad.
12. User-programmable features include the following:

a. Station calling by room number.

b. Room station call-in priority levels.
c. Clock signal schedule functions.
d. Schedule characteristics of audible signals.
e. Call-in tone characteristic.
f. Precedence among master stations as destinations for incoming calls from room stations.
g. Grouping rooms and speakers into zones for paging and program distribution purposes.

13. Telephone interconnect features include the following:

a. Direct connection to central office trunk lines with initial system wiring for 50 trunk lines.
b. Routing of outside trunk lines for "attendant answer incoming" and "direct inward line" functions.
c. Station programming for access to outside trunk lines to be any of the following:

1) Totally unrestricted access.
2) Restricted access.
3) No access.

d. Discriminating ringing for identifying internal and outside calls.
e. Circular hunting for outside trunks to prevent excess usage of any one trunk.
f. Direct connection of a single trunk to designated telephone with transfer to attendant if unanswered.
g. Call parking allowing paged party to remotely pick up outside call from any master station.
h. Night-answer mode to allow one or all of the following:

1) Incoming call transferred to predetermined extension.
2) Tone transmitted to speakers to notify key personnel to answer telephone.
3) Dial tone to remote stations to allow answering call from all locations.

i. Call control console to do as follows:

1) Identify, answer, and route incoming outside calls, with reminder and recall features.
2) Directly access outside trunk lines.
3) Hold, park, and transfer calls.
4) Screen outside calls.

B. Remote Stations:

1. Speaker-Microphone Station:

a. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
b. Communicating hands free.
c. Calling master station by actuating call switch.
d. Returning a busy signal to indicate that station is already in use.

C. Speakers: Free of noise and distortion during operation and when in standby mode.

2.4 GENERAL REQUIREMENTS FOR EQUIPMENT AND MATERIALS

A. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.

C. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz. Comply with UL 813.

D. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.

2.5 MASTER STATION FOR MICROPROCESSOR-SWITCHED SYSTEMS

A. 12-Digit Keypad Selector: Transmits calls to other stations and initiates commands for programming and operation.

B. Volume Control: Regulates incoming-call volume.

C. Tone Annunciation: Momentary audible tone signal announces incoming calls.

D. Lamp Annunciation: Identifies calling stations and stations in use. Lamp remains on until call is answered.

E. Link Button: To transfer calls.

F. Reset Control: Cancels call and resets system for next call.

G. Digital Display: 16-digit alphanumeric LCD readout to register up to four three-digit station numbers.

H. Central-Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices required for conversation channels and control functions.

2.6 CALL CONTROL CONSOLE

A. Microprocessor-based instrument to process outside and internal calls with a 12-digit keypad selector.

B. 20-character alphanumeric display for the following:

1. Simultaneous display of up to three calling stations plus last station dialed.
2. Display of calls in order received with emergency calls taking precedence on the display.
3. Review of calls stored in groups of four.
4. Display of prompt messages to assist in system operation.

C. Programmable Keys: Minimum of 20 with LED indicators for ringing/busy status; programmable for trunk and operator functions.

D. Transfer Button: Calls to busy extensions and unanswered calls automatically returned to call control console.

E. Hold Button: With reminder feature every 30 seconds for parked calls or calls placed on hold.

F. Release Button: For use with parked calls or calls placed on hold.

G. Page Button: For engaging system paging functions.

H. Programmable for night answer, remote answer, and remote pickup features.

I. Programmable for distribution of emergency announcements, all-page announcements, zone-page announcements, and emergency/evacuation alert.

J. Central-Control Cabinet Equipment: Central switching equipment, central office adapter module, line link modules, power supplies, chassis adapters, and other switching and control devices required for trunk and internal conversation channels and control functions.

2.7 SPEAKER-MICROPHONE STATIONS

A. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.

B. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.

C. Back Box: Two-gang galvanized steel with 2-1/2-inch (64-mm) minimum depth.

D. Speaker: Minimum axial sensitivity shall be 91 dB at one meter, with 1-W input. Voice coil shall be not less than 3 inches (76 mm), 2.3 oz. (65 g) minimum; permanent magnet.

E. Tone Annunciation: Recurring momentary tone indicates incoming calls.

F. Call Switch: Mount on faceplate. Permits calls to master station.

G. Privacy Switch: Mount on faceplate. When in on position, switch prevents transmission of sound from remote station to system; when in off position, without further switch manipulation, response can be made to incoming calls.

2.8 CALL-SWITCH UNIT

A. Enclosure: Single-gang box with stainless-steel faceplate.

B. Call Switch: Momentary contact signals system that a call has been placed.

C. Privacy Switch: Prevents transmission of sound signals from station to system.

D. Volume Control: Operated by screwdriver blade through a hole in faceplate to adjust output level of associated speaker.

2.9 ALL-CALL AMPLIFIER

A. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.

B. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to quantity of stations connected in all-call mode of operation.

C. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.

D. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.

E. Output Regulation: Maintains output level within 2 dB from full to no load.

F. Input Sensitivity: Compatible with master stations and central equipment so amplifier delivers full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.

G. Amplifier Protection: Prevents damage from shorted or open output.

2.10 INTERCOMMUNICATION AMPLIFIER

A. Minimum Output Power: 15 W; adequate for all functions.

B. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to one station connected to output terminals.

C. Minimum Signal-to-Noise Ratio: 50 dB, at rated output.

D. Frequency Response: Within plus or minus 3 dB from 70 to 10,000 Hz.

E. Output Regulation: Maintains output level within 2 dB from full to no load.

F. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on microphones in master stations, speaker microphones, or handset transmitters.

G. Amplifier Protection: Prevents damage from shorted or open output.

2.11 PAGING AMPLIFIER

A. Input Voltage: 120-V ac, 60 Hz.

B. Frequency Response: Within plus or minus 3 dB from 60 to 10,000 Hz.

C. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.

D. Total Harmonic Distortion: Less than 3 percent at rated output power from 70 to 12,000 Hz.

E. Output Regulation: Less than 2 dB from full to no load.

F. Controls: On-off, input levels, and low-cut filter.

G. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphones or handset transmitters.

H. Amplifier Protection: Prevents damage from shorted or open output.

2.12 HORN-TYPE LOUDSPEAKERS/SPEAKER MICROPHONES

A. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.

B. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.

C. Minimum Power Rating of Driver: 15 W, continuous.

D. Minimum Dispersion Angle: 110 degrees.

E. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

2.13 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch (483-mm) housing complying with TIA/EIA-310-D.

D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.14 POWER AMPLIFIERS

A. Mounting: Rack.

B. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.

C. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.

D. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.

E. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.

F. Output Regulation: Less than 2 dB from full to no load.

G. Controls: On-off, input levels, and low-cut filter.

H. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

2.15 TRANSFER TO STANDBY AMPLIFIER

A. Monitoring Circuit and Sensing Relay: Detect reduction in output of power amplifier of 40 percent or more and, in such event, transfer load and signal automatically to standby amplifier.

2.16 MICROPHONES

A. Paging Microphone:

1. Type: Dynamic, with cardioid polar characteristic.
2. Impedance: 150 ohms.
3. Frequency Response: Uniform, 50 to 14,000 Hz.
4. Output Level: Minus 58 dB, minimum.
5. Finish: Satin chrome.
6. Cable: C25J.
7. Mounting: Desk stand with integral-locking, press-to-talk switch.

2.17 VOLUME LIMITER/COMPRESSOR

A. Minimum Performance Requirements:

1. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.
2. Signal Reduction Ratio: At least a 10:1 and 5:1 selectable capability.
3. Distortion: 1 percent, maximum.
4. Rated Output: Minimum of plus 14 dB.
5. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
6. Rack mounting.

2.18 CONTROL CONSOLE

A. Cabinet: Modular, desktop; complying with TIA/EIA-310-D.

B. Housing: Steel, 0.0478 inch (1.2 mm) minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.

C. Panel for Equipment and Controls: Rack mounted.

D. Controls:

1. Switching devices to select signal sources for distribution channels.
2. Program selector switch to select source for each program channel.
3. Switching devices to select zones for paging.
4. All-call selector switch.

E. Indicators: A visual annunciation for each distribution channel to indicate source being used.

F. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.

G. Spare Positions: 20 percent spare zone control and annunciation positions on console.

H. Microphone jack.

2.19 EQUIPMENT CABINET

A. Comply with TIA/EIA-310-D.

B. House amplifiers and auxiliary equipment at each location.

C. Cabinet Housing:

1. Constructed of 0.0478-inch (1.2-mm) steel, minimum, with front- and rear-locking doors and standard TIA/EIA-310-D-compliant, 19-inch (483-mm) racks.
2. Arranged for floor or wall mounting as indicated.
3. Sized to house all equipment indicated, plus spare capacity.
4. Include 20 percent minimum spare capacity for future equipment in addition to space required for future cassette deck and CD player.

D. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.

E. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

2.20 TELEPHONE PAGING ADAPTER

A. Adapters shall accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.

1. Minimum Frequency Response: Flat, 200 to 2500 Hz.
2. Impedance Matching: Adapter matches telephone line to public address equipment input.
3. Rack mounting.

2.21 TONE GENERATOR

A. Generator shall provide clock and program interface with public address and mass notification system.

B. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.

C. Pitch Control: Chimes and tone.

D. Volume Control: All outputs.

E. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.

F. Mounting: Rack.

2.22 MONITOR PANEL

A. Monitor power amplifiers.

B. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.

C. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.

D. Mounting: Rack.

2.23 LOUDSPEAKERS

A. Horn-Type Loudspeakers:

1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
2. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
3. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
4. Dispersion Angle: 130 by 110 degrees.
5. Mounting: Integral bracket.
6. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located.
7.

2.24 NOISE-OPERATED GAIN CONTROLLER

A. Gain controller shall be designed to continuously sense space noise level and automatically adjust signal level to local speakers.

B. Frequency Response: 20 to 20,000 Hz, plus or minus 1 dB.

C. Level Adjustment Range: 20 dB minimum.

D. Maximum Distortion: 1 percent.

E. Control: Permits adjustment of sensing level of device.

2.25 OUTLETS

A. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.

1. Wattage Rating: 10 W unless otherwise indicated.
2. Attenuation per Step: 3 dB, with positive off position.

3. Insertion Loss: 0.4 dB maximum.
4. Attenuation Bypass Relay: Single pole, double throw. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
5. Label: "PA Volume."

B. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.

2.26 BATTERY BACKUP POWER UNIT

A. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.

B. Unit shall supply public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.

C. Battery shall be on float charge when not supplying system and to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.

D. Unit shall automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

2.27 CLASSROOM AMPLIFICATION SYSTEM

A. The classroom amplification system shall be better than or equivalent to Top Cat with PageFirst option for PA system override.

B. The system shall provide a solution to deliver sound from the teacher’s desktop and a wireless mic to all areas of the classroom.

C. Install classroom amplification in the following classrooms:
1. Language Labs
2. Library/Maker Space Rooms
3. Kindergarten Classrooms
4. First Grade Classrooms
5. Pre-K Classrooms
6. SB Resource Room
7. Resource Rooms
8. Design Lab
9. Digital Art Lab
10. Music Room
11. Platform
12. Fourth Grade Classrooms
13. Fifth Grade Classrooms
14. Science classrooms
15. Robotics Classrooms
16. Second Grade Classrooms

D. The local sound system shall provide a solution for taechers to utilize the overhead paging speakers to deliver sound to from their classroom computers and LCD Projectors providing an integrated sound system in all classrooms. The local sound systems shall be interconnected with the main sound system described above, which shall be capable of overriding any local systems for announcements made to area covered by the local sound systems irrespective of whether the local systems are “ON” or “OFF”. The same shall apply to override of fire alarm.

E. The system should be compatible with utilizing an assisted listening system as needed.

F. Classroom local sound/speakers shall be free of noise and distortion during operation and when in standby mode, including “humming” and “buzzing”.

2.28 ASSISTED LISTENING SYSTEM

A. General

1. The assisted listening system shall be portable with wireless antennae mounted in the assembly spaces and classrooms.
2. The system shall be radio frequency based with no limited as to the number of users
3. The assisted listening system shall be integral to the assembly space voice amplification system.
4. The system shall be in accordance with rules and regulations as outlined in the American with Disabilities Act sections 291 and 706.

B. Transmitter

1. The transmitted shall operate on a 20 amp 120 volt AC 60Hz circuit.
2. The transmitter shall operate on an FM radio frequency of 72 to 76 MHz.
3. There shall be 1-monatural audio channel.
4. There shall be a line level audio input.
5. The transmitter shall LED indicators for power and audio input.
6. The system shall have a 6’ three wire cord and plug with ground wire for power connections.
7. The signal-to-noise ratio for internally generated noise shall be a minimum of 18dB as per 706.5.
8. The signal shall peak clipping not to exceed 18dB of clipping relative to the peaks of speech as per 706.6.

C. Receivers

1. The number and type of wireless receivers to be provided on the project shall be as indicated on the drawings.
2. Standard receivers shall include an 1/8” (3.2mm) standard mono jack as per 706.2.
3. Hearing-aid compatible receivers shall interface with telecoils in the hearing aids through the provisions of neckloops as per 706.3
4. Receivers shall be capable of providing sound pressure levels of 110dM (min) to 118 dB (max) with a dynamic range on the volume control of 50dB as per 706.4.
5. The audio output of the receivers shall be adjustable 2.5v rms.
6. Standard receivers shall be either single ear buds or headset type.
7. The frequency response for the receivers shall be 50 to 15,00 HZ/ +/- 3dB.
8. Receivers shall be battery powered. Provide spare batteries equal to not less than 10% of the indicated number of receivers.

D. Acceptable Manufactures

1. Transmitters: The assisted listening transmitters shall be Telex ST-300 17 channel transmitters with LCD display or engineer approved equal.
2. Standard receivers: The standard assisted listening transmitters shall be Telex SR-400 17 channel portable type receivers with Telex DEB-2 dual ear bud speakers or engineer approved equal.
3. Hear aid compatible neckloop receiver shall be Telex NL-S4 type or engineer approved equal
4. Manufactures whose products are considered equal are listed below. Contractor shall obtain engineer approval for each individual product prior to substituting.
   a. Williams Sound
   b. R.L. Drake
   c. Comtek

2.29 CAFETERIA LOCAL SOUND SYSTEM

A. This system provides a local announcements from a wireless handheld mic and playback of recorded material. In addition, it also provides an ADA Hearing Impaired System.

B. Provide a 16 space swing out wall mount cabinet better than or equivalent to Middle Atlantic DWR-12-26PD which shall be located in the Storage Room in the Gym Office V119. Include all front door, top vent, assembliesas required to provide an accessible and lockable cabinet. The AV Wall mount cabinet for the Cafeteria sound system shall be mounted above the floor-mounted AV Cabinet in the Storage Room in the Gym Office V119.

C. The Upper AV faceplate in the Cafeteria shall contain inputs and volume controls required for the Cafeteria Local Sound System.

D. Pendant speakers should be used and placed strategically in the cafeteria. Note: these pendant speakers are not shown on the drawings. Contractor must coordinate with the owner's project manager and other trades to determine best locations for the speakers to provide ample sound to the Cafeteria.

E. The Contractor will provide all materials and all necessary labor to complete said Sound System in compliance with this specification. Where a conflict exists with other specifications concerning such materials and labor, this specification takes precedence unless otherwise addressed in writing by the owner or owner's representative. Components shall include but not be limited to:
   1. 2 Vocal Microphones with Cables, better than or equivalent to Shure PG-58XLR
   2. 2 50' Mic Cables better than or equivalent to ProCo ME-50
   3. 2 Mic Input Plates better than or equivalent to ProCo WP1004
   4. 1 Microsphone Stand better than or equivalent to Atlas MS12-CE
   5. 1 Mixer/Preamplifer better than or equivalent to Rane MLM82S
   6. 1 Feedback Controller MLM82S Shure DRF22
   7. 2 Stereo input cables/adapters necessary for input from an external music source such as an iPhone or iPad
   8. 1 Power Amplifier better than or equivalent to Crown
   9. 1 Mute Control Relay w/ Power Supply better than or equivalent to Bogen
   10. 1 Silent Mute Unit w/ Power Supply better than or equivalent to RDL
   11. 1 ADA System better than or equivalent to Listen
   12. 14 ADA Receivers better than or equivalent to Listen
   13. 14 ADA Ear Bud better than or equivalent to Listen
   14. 5 ADA Neck Loops better than or equivalent to Listen
   15. 1 Power Strip better than or equivalent to PDS-620R Middle Atlantic

16. 12 or more pendant ceiling speakers better than or equivalent to JBL Control 67HC/T

F. The purpose of the local sound system in the cafeteria is provide a sound system as described above for the cafeteria area only, when dividers to the gymatorium side are closed. The system will be stand-alone and not integrated with the gymatorium system.

G. The contractor may propose a solution that differs from the above listed components. It is the responsibility of the contractor to install a complete system with appropriate sound coverage.

H. Coordinate pendant speaker locations with owner's project manager and others as required to work around ceiling structures.

2.30 GYMATORIUM LOCAL SOUND SYSTEM

A. The gymatorium local sound system will consist of a complete audio visual system to provide playback of recorded audio, presentation from computer systems and/or the th e data network and presentations and performances. The gymatorium local sound system will consist of the following areas/zones:
1. Gymatorium
2. Gymatorium & Cafeteria
3. Exterior Platform
4. Exterior Platform & Gymatorium
5. Exterior Platform, Gymatorium and Cafeteria

B. The above information is provided for reference only to provide the Contractor with a better understanding of the project and integration.

C. The above described system and required components will be furnished by the others during the FF&E phase of the project; however, the Contractor shall provide coordination as needed in order to ensure the Gymatorium system is integrated with the PA system for PA system overrides and fire alarm overrides.

2.31 CONDUCTORS AND CABLES

A. Jacketed, twisted pair and twisted multipair, untinned solid copper.

1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch (0.8 mm) thick. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch (0.8 mm) thick, over shield with filled interstices. Shielded, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
3. Plenum Cable: Listed and labeled for plenum installation. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.

2.32 RACEWAYS

A. Conduit and Boxes: Comply with Section 260533 "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.33 UPSs

A. Provide sufficient backup power as appropriate per the manufacturer’s recommendations.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF RACEWAYS

A. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. 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.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Equipment Cabinets and Racks:

1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

D. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.

E. Wall-Mounted Outlets: Flush mounted.

F. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

G. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

H. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

I. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing public address and mass notification systems and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
    b. Repeat test for each separately controlled zone of loudspeakers.
    c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.

6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at pubic address equipment signal ground. Comply with testing requirements specified in Section 260526 "Grounding and Bonding for Electrical Systems."

C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

D. Public address and mass notification systems will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address and mass notification systems and equipment.

3.10 COMMISSIONING

A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 019113 – General Commissioning Requirements.

B. Complete installation and startup checks and functional tests according to Section 019113 – General Commissioning Requirements and manufacturers written instructions.

C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the tart up procedure.

D. Verify that equipment is installed and commissioned as per requirements of Section 019113 and manufacturers written instruction/requirements.

END OF SECTION 275116

SECTION 275313 - CLOCK 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.

B. Section 019113-General Commissioning Requirements.

C. Technology drawings.

D. “E” Drawings.

E. Section 275116 – Public Address and Mass Notification Systems.

1.2 SUMMARY

A. Section Includes:

1. Master clock and program control unit.
2. Secondary indicating clocks.
3. Program signal devices.
4. Clock circuit power boosters.
5. Interface with intercom and public-address system.

1.3 DEFINITIONS

A. NIST: The National Institute of Science and Technology.

B. PC: Personal computer.

C. UTC: Universal time coordinated. The precisely measured time at zero degrees longitude; a worldwide standard for time synchronization.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Master clock and housing shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. CTHPB Documentation Submittals: Comply with Division 01 Section “Sustainable Design Requirements” and provide the following in addition to other action submittals:

1. Product Data for Credit 5d: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit 5d: For paints and coatings, including printed statement of VOC content.
3. Product Data for Credit d8: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
4. Product Certificates for Credit d10: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
5. Certificates for Credit d13: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
6. Laboratory Test Reports for Credit b4: For composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual, for the following:

1. Master unit.
2. Indicating clocks.
3. Signal equipment.
4. Equipment enclosures and back boxes.
5. Accessory components.

C. Shop Drawings: For clock systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring and correction circuits.

    a. Identify terminals and wiring color codes to facilitate installation, operation, and maintenance.
    b. Indicate recommended wire types and sizes, and circuiting arrangements for field-installed system wiring. Show protection from overcurrent, static discharge, and voltage surge.

2. Details of seismic restraints including mounting, anchoring, and fastening devices for the following system components:

    a. Surface-mounted and semi-recessed secondary indicating clocks.
    b. Master clock enclosures.

c. Clock circuit power boosters.

3. Details of seismic strengthening of master clock enclosures.
4. Dimensioned Outline Drawings of the Mounting Rack for the Master Clock: Show internal seismic bracing, and locate center of gravity of fully equipped and assembled unit. Locate and describe mounting and anchorage provisions.

D. Samples for Initial Selection:

1. Manufacturer's color photographs or color chips showing the full range of colors available for clocks, signal equipment, and control panels.

E. Delegated-Design Submittal: For the master clock and housing 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 the master clock and housing.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For the master clock, 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.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For clock and program control to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MASTER AND SECONDARY CLOCK SYSTEM

A. Manufacturers: The clock system shall be better than or equivalent to Bogen.

B. System Functions and Features:

1. Supply power to remote indicating clocks.
2. Maintain correct synchronized time and transmit time-correction signals over dedicated system wiring from a master clock to any one type of secondary indicating clocks, including the following:

    a. Analog Synchronous Clocks: Correct for minute- and second-hand synchronization at least once each hour and for hour-hand synchronization at least once each day.

3. Initiate and execute programs for scheduled automatic operation of remote devices. Include audible signal devices.
4. Provide for manual control of programmed signal and equipment-switching circuits.
5. Communicate with remote PC for access to UTC time base and to permit programming from remote location.
6. Maintain system access security with a minimum of two levels of user-access control to restrict use of system controls to authorized personnel. Levels of access apply to both local access and access from a remote computer. Access to user programming and control functions is accomplished by entering a minimum three-digit code. Access levels include the following:

    a. Access to review existing programs only.
    b. Access to normal system operating controls.
    c. Access to all user-programming and control functions.

7. Regulate system timing functions using power-line frequency, backed up for power outages by an internal battery-powered, crystal-controlled oscillator, and automated periodic reference to NIST or UTC time signals via dedicated internal radio receiver tuned to NIST time signal broadcasts. Reference time signals shall be automatically accessed at programmable intervals.
8. Provide for programming multiple independent event schedules into memory and running them simultaneously for different output circuits.

    a. Quantity of Programmable Schedules: 18, minimum.
    b. Number of Weekly Events That Can Be Programmed for Each Schedule: 600, minimum.
    c. Simultaneous operation of independent schedules shall be limited only by the number of signal-device and equipment-switching output circuits.
    d. Advance Programming for Automatic Holiday Schedule Changes: Number of schedule changes that can be programmed to suit holidays and vacations shall be 16, and each change may be programmed up to a year in advance to occur on any day of the calendar year.

9. Automatically check functioning of LEDs, switches, input keys, central processor, read-only memory, random access memory, and output circuits. A display on the control panel or a remote computer with the proper access code shall indicate failure by identifying faulty component or circuit and shall recommend corrective action.
10. Provide programming for automatic daylight savings time correction.
11. Provide for adjustments to master clock output signals. Duration of momentary signal shall be individually programmable for each signal and equipment-control output circuit from 1 to 99 seconds. Signals shall be programmable for either on or off switching to suit equipment-operation scheduling.

2.2 MASTER CLOCK

A. Description: Microprocessor-based, software-controlled unit complying with Class A device requirements in 47 CFR 15.

1. Programming and control switches.
2. Informational Display: LED or backlit LCD type.

    a. Normally shows current time, date, and day of week display.

3. Output Circuits for Power and Correction of Secondary Indicating Clocks:

    a. Wired Synchronous Clock Power-and-Correction Circuits: For analog clocks; a minimum of one required. Relay controlled.

4. Data Output Port for Secondary Clock Correction Circuit: RS485 or similar circuit for scheduled periodic correction signals.
5. Modem and PC interface software suitable for remote programming and automatic NIST or UTC synchronization.
6. Circuits for Audible Signal Devices: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, five A minimum. A minimum of two circuits.
7. Circuits for Programmable Switching of Remote Equipment and Circuits: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, 5 A minimum. A minimum of two circuits.
8. Power Supplies: Capacity for internal loads and power-and correction circuits of connected clocks.
9. Enclosure: Metal cabinet with locking front panel. When cabinet is locked, display indication shall be visible on or through front panel face. Arrange cabinet for surface, semi-recessed, or flush mounting as indicated.

    a. Reinforce mounting and attachment capable of resisting seismic forces described in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

10. Battery Backup for Time Base: Lithium battery to maintain the timekeeping function and retain the programs in memory during outage of normal ac power supply for up to 10 years.
11. Electrostatic Discharge Resistance: Master clock shall be tested and certified according to IEC 61000-4-2 in both human-discharge and direct-injection modes.

2.3 SECONDARY INDICATING CLOCKS

A. Analog Clock: Equipped with a sweep second hand. Movement shall be driven by self-starting, permanently lubricated, sealed synchronous motor equipped with a correcting solenoid actuator, or be a microprocessor-based, second impulse unit, compatible with the master clock.

B. Provision for Modular Panel Installation: Equip designated clock for panel mounting. Mount flush or semi-recessed with arrangement and trim as indicated. Coordinate wiring with other modular panel components, including intercom devices speaker and other similar devices.

C. Provision for Time-Tone-Unit Installation: Equip indicated clocks for housing or mounting in an acoustically treated and baffled speaker compartment specified in Section 275116 "Public Address and Mass Notification Systems."

D. Secondary Indicating Clock Characteristics:

1. Clock Type: Analog.
2. Face Configuration: Single.
3. Mounting: Recessed.
4. Nominal Dimensions: 12 inches (300 mm).
5. Casing Finish: Black.
6. Dial Face Color: White.
7. Analog Clock Crystal: Clear polycarbonate.

2.4 PROGRAM SIGNAL DEVICES

A. Bells: Heavy-duty, modular, vibrating type with the following sound-output ratings measured at 10 feet (3 m):

1. 4-Inch (100-mm) Bell: 90 dB.
2. 6-Inch (150-mm) Bell: 95 dB.
3. 10-Inch (250-mm) Bell: 104 dB.

B. Chimes: Heavy-duty, modular, vibrating chimes with polished-chrome tone bar and enamel-finished housing. Minimum sound-output rating measured at 10 feet (3 m) shall be 75 dB.

C. Clock Buzzers: Adjustable output signal device designed for mounting within clock housing or outlet box.

1. Sound-Output Rating Measured at 3 Feet (1 m): 75 dB.
2. Audible Tone Frequency: Manufacturer's standard between 120 Hz and 2 kHz.

D. Horns: Modular, adjustable-output, vibrating type with minimum full-intensity-rated sound output of 103 dB measured at 10 feet (3 m).

E. Projector Horns: Adjustable-output, vibrating type with single projector arranged to channel sound in the direction of the projector axis, and with minimum full-intensity-rated sound output of 104 dB measured at 10 feet (3 m).

F. Loudspeakers for Audible Tones: See Section 275116 "Public Address and Mass Notification Systems."

G. Outdoor Signal Equipment: Weatherproof models listed for outdoor use.

H. Mounting Arrangement for Signal Devices: Designed for attachment with screws on the mounting plate of a flush-mounted back box unless otherwise indicated.

I. Enclosures for Flush-Mounting Bells and Horns: Enclosure, mounting plate, and grille assembly shall be furnished by device manufacturer to match features of the device to be mounted. Enclosure shall be recessed in wall, completely enclosing the device, with grille mounting over the open side of the enclosure and flush with the wall.

J. Connection Provision for Signal-Indicating Devices: Wire pigtail or compression splice.

2.5 CLOCK CIRCUIT POWER BOOSTER

A. Description: Transformer power supply, mounted in steel cabinet with hinged door, and having fuse-protected input and output circuits.

2.6 BACK BOXES FOR SECONDARY INDICATING CLOCKS AND PROGRAM DEVICES

A. Description: Box and cover-plate assembly shall be furnished by device manufacturer and be suitable for device to be mounted. Back boxes shall be equipped with knockouts and hanger straps or mounting adapters arranged for flush mounting the device unless otherwise indicated.

2.7 GUARDS

A. Description: Formed-steel wire, shaped to fit around guarded device, with 1-inch (25-mm) maximum clearance.

1. Mounting Provisions: Fixed tabs, welded to guard and arranged for screw attachment to mounting surface.
2. Finish for Indoor Devices: Clear epoxy lacquer over zinc plating.
3. Finish for Outdoor Devices: Black powder coat over zinc plating and primer.

B. Provide Guards where appropriate, in gymatorium.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount system components with fastening methods and devices designed to resist the seismic forces indicated in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Support cables not enclosed in raceways on J-Hooks. Install, size, and space J-Hooks to comply with TIA/EIA-568-B.

3.3 ELECTRICAL CONNECTIONS

A. Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

B. Use splices for connections to clocks and signal devices.

C. Ground clocks, programming equipment, and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.4 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Color-code wires, and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.

3.5 ADJUSTING

A. Program system according to Owner's requirements. Set system so signal devices operate on Owner-required schedules and are activated for durations selected by Owner. Program equipment-control output circuits to suit Owner's operating schedule for equipment controlled.

B. Adjust sound-output level of adjustable signal devices to suit Owner's requirements.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clock-and-program-control system components.

3.7 COMMISSIONING

A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 019113 – General Commissioning Requirements.

B. Complete installation and startup checks and functional tests according to Section 019113 – General Commissioning Requirements and manufacturers written instructions.

C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the tart up procedure.

D. Verify that equipment is installed and commissioned as per requirements of Section 019113 and manufacturers written instruction/requirements.

END OF SECTION 275313

SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section “Summary”, Paragraph 1.1A, entitled “Related Documents.”

B. 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. RS-485 cabling.
3. Low-voltage control cabling.
4. Control-circuit conductors.
5. Identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. 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.

1.4 ACTION SUBMITTALS

A. CTHPB Documentation Submittals: Comply with Division 01 Section “Sustainable Design Requirements” and provide the following in addition to other action submittals:

1. Product Data for Credit 5d: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit 5d: For paints and coatings, including printed statement of VOC content.
3. Product Data for Credit d8: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
4. Product Certificates for Credit d10: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material

manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.

5. Certificates for Credit d13: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
6. Laboratory Test Reports for Credit b4: For composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL).

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

1.8 FIELD CONDITIONS

A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial 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.

C. The Telecommunications Contractor shall ensure that the General Contractor and Painting Contractor acknowledge that painting of or over spray any single or group of 4 pair horizontal telecommunications

Category 5e or Category 6 cable is not allowed. Any painted or over sprayed cable(s) shall be replaced at the painting contractor's expense. Painted Cable will not be covered as part of an extended warranty. Painted cable in addition to obscuring the print legend may act as an accelerant or create an additional smoke hazard in the event of a fire and as such this is considered a life safety issue.

PART 2 - PRODUCTS

2.1 PERFORMANCE 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.

2.2 BACKBOARDS

A. Backboards: provided by Division 26. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry." Refer to Division 26 and "E" drawings.

2.3 UTP CABLE

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. Belden Inc.

B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.

   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with ANSI/TIA -568-C.1 for performance specifications.
   3. Comply with ANSI/TIA -568-C.2, Category 6a.
   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 or MPP, complying with NFPA 262.
      b. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.

2.4 UTP CABLE HARDWARE

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. Belden Inc.

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 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

2.5 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation. May want to change to a specified Flame and Smoke Retardant.
3. Unshielded.
4. Fluorinated ethylene propylene jacket. May want to change to a specified Flame and Smoke Retardant jacket material , FEP jacket would be very expensive and require a marker tape under the jacket. Flame and Smoke Retardant jacket material will meet NFPA 262 and NFPA 70 plenum.
5. Flame Resistance: NFPA 262, Flame Test.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC plenum rated insulation.
3. Unshielded.
4. PVC plenum rated jacket.
5. Flame Resistance: Comply with NFPA 262.

2.7 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.

2.8 IDENTIFICATION PRODUCTS

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. 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."

2.9 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 ANSI/TIA -568-C.1.

C. Factory test UTP cables according to ANSI/TIA -568-C.2.

D. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

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 HANGERS AND SUPPORTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

3.2 WIRING METHOD

A. Install wiring in metal pathways and wireways refer to Division 26 and “E” drawings.

B. Install cable, concealed in accessible ceilings, walls, and floors when possible.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. General Requirements for Cabling:

1. Comply with ANSI/TIA -568-C.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 (760 mm) and not more than 6 inches (150 mm) 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.

D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6a rating of components and that ensure Category 6a performance of completed and linked signal paths, end to end.

1. Comply with ANSI/TIA -568-C.2.
2. Install 110-style IDC termination hardware unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and ANSI/TIA-569-D 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 nonmetallic 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 (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

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 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between 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 (75 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. 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 CONNECTIONS

A. Comply with requirements in Section 281600 "Intrusion Detection" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Section 281300 "Access Control" for connecting, terminating, and identifying wires and cables.

C. Comply with requirements in Section 282300 "Video Surveillance" for connecting, terminating, and identifying wires and cables.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-B, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.7 GROUNDING

A. For communications wiring, comply with ANSI/TIA-607-C 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."

C. Refer to Division 26 and “E” drawings for further instructions and requirements.

3.8 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. 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.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 280513

SECTION 280529 - HANGERS AND SUPPORTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Sleeves.
5. Mechanical sleeve seals.
6. Firestopping relating to electrical work.
7. Firestopping accessories.
8. Equipment bases and supports.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
2. Division 07 Section – Penetration Firestopping.
3. Section 26 05 29 - Hangers and Supports for Electrical Systems.
4. Section 27 05 29 - Hangers and Supports for Communications Systems.

1.2 REFERENCES

A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

B. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

D. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
   2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

E. Design Data: Indicate load carrying capacity of [trapeze hangers] [and] [hangers and supports].

F. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

H. Engineering Judgements: For conditions not covered by UL listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum years experience approved by manufacturer.

1.5 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. Electroline Manufacturing Company.
3. O-Z Gedney Co.
4. Thomas and Betts
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems.
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.
5. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

A. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for conduit, cable tray, raceway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

D. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. PSI Link-Seal.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
1. Concrete Structural Elements: Provide precast inserts and expansion anchors.
2. Steel Structural Elements: Provide beam clamps, spring steel clips, and welded fasteners.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:
1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted cabinets and panelboards with minimum of four anchors.
3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
4. Support vertical conduit at every floor.

3.3 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.4 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install chrome plated steel escutcheons at finished surfaces.

3.5 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

3.6 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

END OF SECTION

SECTION 280533 - CONDUITS AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:
1. Division 7 Section – Penetration Firestopping.
2. Section 26 05 03 - Equipment Wiring Connections.
3. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
4. Section 26 27 26 - Wiring Devices.
5. Section 27 05 33 - Conduits and Backboxes for Communications Systems.
6. Section 28 05 29 - Hangers and Supports for Electronic Safety and Security.
7. Section 28 05 53 - Identification for Electronic Safety and Security.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.

B. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
5. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground More than 5 feet outside Foundation Wall: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.

C. Underground Within 5 feet from Foundation Wall: Provide rigid steel conduit. Provide cast metal or nonmetallic boxes.

D. In or Under Slab on Grade: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide rigid steel conduit sweeps.

E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.

F. Wet and Damp Locations: Provide rigid steel conduit, electrical metallic tubing. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.

G. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

H. Exposed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

1.4 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit for the following:
1. Liquidtight flexible metal conduit.
2. Nonmetallic conduit.
3. Nonmetallic tubing.
4. Raceway fittings.
5. Conduit bodies.
6. Surface raceway.
7. Wireway.
8. Pull and junction boxes.
9. Handholes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:
1. Record actual routing of conduits larger than 2 inch.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.8 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.

C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; all steel fittings.

2.2 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Anamet Electrical.
3. Allied Tube and Conduit.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Interlocked steel construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel, compression (damp locations), and set screw type.

2.4 SURFACE METAL RACEWAY

A. Manufacturers:
1. Hubbell Wiring Devices.

2. Thomas & Betts Corp.
3. The Wiremold Co.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. Size: as indicated on drawings.

D. Finish: Manufacturers standard finish as selected by Architect.

E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.5 OUTLET BOXES

A. Manufacturers:
1. Erico Products.
2. Raco.
3. Thomas & Betts Corp.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

D. Wall Plates for Finished Areas: As specified in Section 26 27 26.

E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.6 PULL AND JUNCTION BOXES

A. Manufacturers:
1. Carlon Electrical Products.
2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Hinged Enclosures: As specified in Section 26 27 16.

D. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
1. Material: Galvanized cast iron.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

E. Concrete Composite Handholes: Die-molded, concrete composite hand holes:
1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.

2. Cover: Concrete composite, weatherproof cover with nonskid finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.

B. Remove concealed abandoned raceway to its source.

C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.

D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.

E. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.

F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 26 05 26.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.

C. Identify raceway and boxes in accordance with Section 26 05 53.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.4 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in Section 26 05 29.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit under slab from point-to-point.

K. Maintain clearance between raceway and piping for maintenance purposes.

L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

M. Cut conduit square using saw or pipe cutter; de-burr cut ends.

N. Bring conduit to shoulder of fittings; fasten securely.

O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.

R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

W. Close ends and unused openings in wireway.

3.5 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights as specified in section for outlet device.

B. Coordinate communications device locations with furniture plan and receptacle locations to accommodate the intended purpose prior to rough-in.

C. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

D. Orient boxes to accommodate wiring devices oriented as specified in Section 271343.

E. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

F. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

G. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

H. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

I. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

J. Install stamped steel bridges to fasten flush mounting outlet box between studs.

K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

L. Install adjustable steel channel fasteners for hung ceiling outlet box.

M. Do not fasten boxes to ceiling support wires or other piping systems.

N. Support boxes independently of conduit.

O. Install gang box where more than one device is mounted together. Do not use sectional box.

P. Install gang box with plaster ring for single device outlets.

3.6 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 07 Section “Penetration Firestopping”.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.

C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.7 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.8 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 280553 - IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.
5. Underground Warning Tape.
6. Lockout Devices.

B. Related Sections:
1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.
2. Section 26 05 53 - Identification for Electrical Systems.
3. Section 27 05 53 - Identification for Communications Systems.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data:
1. Submit manufacturer’s catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept identification products on site in original containers. Inspect for damage.

C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Install labels only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.

C. Letter Size:
1. 1/8 inch high letters for identifying individual equipment and loads.
2. 1/4 inch high letters for identifying grouped equipment and loads.

D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Labels: Embossed, pre-printed adhesive tape, with 3/16 inch white letters on black background.

2.3 WIRE MARKERS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Cloth tape or split sleeve type wire markers.

C. Legend:
1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on Drawings.
2. Control Circuits: Control wire number as indicated on shop drawings.

2.4 CONDUIT AND RACEWAY MARKERS

A. Manufacturers:
1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Nameplate fastened with straps.

C. Color:
1. Fire Alarm System: Red lettering on white background.
2. Security System (Access Control, Intrusion Detection &Video Surveillance): White lettering on black background.

D. Legend:
1. Fire Alarm System: FIRE ALARM.
2. Access Control System: ACCESS CONTROL.
3. Intrusion Detection: ALARM.
4. Video surveillance: CCTV.

2.5 LOCKOUT DEVICES

A. Lockout Hasps:
1. Manufacturers:
a. Master Lock.
b. Ideal Industries.
c. Brady.
d. Substitutions: Section 01 60 00 - Product Requirements.
2. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:
1. Install nameplate parallel to equipment lines.
2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
4. Secure nameplate to equipment front using screws.

5. Install nameplates for the following:
    a. Equipment racks and cabinets.

C. Label Installation:
1. Labeling procedures shall meet TIA/EIA 568B Series standard and BICSI Standards and shall be pre-approved by the Architect.
2. Permanently label, using pre-printed labels, all cables and terminations.
    a. Patch panels and cross-connect blocks, numerically from top to bottom.
    b. Patch panel port with work area outlet label.
    c. Cable segments.
3. Install label parallel to equipment lines.
4. Use industry standard TIA/EIA and BISCI color codes.

D. Wire Label Installation:
1. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
2. Install labels at data outlets identifying patch panel and port designation as specified.

E. Conduit Marker Installation:

1. Install conduit marker for each conduit longer than 10 feet.

2. Conduit Marker Spacing: 20 feet on center.

END OF SECTION

SECTION 281300 - ACCESS CONTROL

PART 1 - General

1.1 RELATED DOCUMENTS

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

B. Section 019113-General Commissioning Requirements.

C. Technology Drawings and Section 27

D. Sections 087100 Door Hardware

E. “E” Drawings and Section 26

1.2 SUMMARY

A. Section Includes:

1. Security access central-control station.
2. One or more security access networked workstations.
3. Security access operating system and application software.
4. Security access controllers connected to high-speed electronic-data transmission network.
5. Video Intercom Stations

1.3 DEFINITIONS

A. CCTV: Closed-circuit television.

B. CPU: Central processing unit.

C. Credential: Data assigned to an entity and used to identify that entity.

D. dpi: Dots per inch.

E. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

F. GFI: Ground fault interrupter.

G. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

H. I/O: Input/Output.

I. LAN: Local area network.

J. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

K. PC: Personal computer. Applies to the central station, workstations, and file servers.

L. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.

M. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.

N. RAS: Remote access services.

O. RF: Radio frequency.

P. ROM: Read-only memory. ROM data are maintained through losses of power.

Q. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

R. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

S. UPS: Uninterruptible power supply.

T. USB: Universal serial bus.

U. WAN: Wide area network.

V. WAV: The digital audio format used in Microsoft Windows.

W. WMP: Windows media player.

X. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

Y. Windows: Operating system by Microsoft Corporation.

Z. Workstation: A PC with software that is configured for specific, limited security-system functions.

AA. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.4 ACTION SUBMITTALS

A. CTHPB Documentation Submittals: Comply with Division 01 Section “Sustainable Design Requirements” and provide the following in addition to other action submittals:

1. Product Data for Credit 5d: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit 5d: For paints and coatings, including printed statement of VOC content.
3. Product Data for Credit d8: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
4. Product Certificates for Credit d10: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
5. Certificates for Credit d13: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
6. Laboratory Test Reports for Credit b4: For composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Diagrams for cable management system.
2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:

    a. Workstation outlets, jacks, and jack assemblies.
    b. Patch cords.
    c. Patch panels.

4. Cable Administration Drawings: As specified in "Identification" Article.
5. Battery and charger calculations for central station, workstations, and controllers.

D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

E. Other Action Submittals:

1. Project planning documents as specified in Part 3.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Microsoft Windows software documentation.
2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
4. System installation and setup guides with data forms to plan and record options and setup decisions.

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. Laser Printers: Three toner cassettes and one replacement drum unit.
2. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.
3. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

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.

D. Comply with NFPA 70, "National Electrical Code."

E. Comply with SIA DC-03.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Central Station, Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F (10 and 30 deg C), and not more than 80 percent relative humidity, noncondensing.
2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F (16 to 30 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in air-conditioned indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Indoor, Uncontrolled Environment: NEMA 250, Type 3R enclosures. System components installed in non-air-conditioned indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Outdoor Environment: NEMA 250, NEMA 250, Type 3R enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.

1.11 Warranty

A. The Access Control Panel shall be warranted for at least 12 months from the date of system acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Better than or equivalent to Continental Instruments; a NAPCO Security Group company. Continental Access Control system and CA4K.

B. The system must be compatible with and integrate the wireless door locks which will be better than or equivalent to Trilogy Networx Wireless Access Locks provided by others. The wireless door locks shall be provisioned under Section 087100 and provided by the door vendor.

C. The Video Intercom System shall be better than or equivalent to AIPHONE.

2.2 VIDEO INTERCOM DESCRIPTION

A. The video intercom system, better than or equivalent to AIPHONE shall provide two way audio communications between the exterior door location as indicated on the drawings and the master and sub stations door release locations as indicated on the drawings.

B. The system will provide audio and video including video identification enabling staff to identify visitors before letting them inside.

C. Door release locations will provide a mechanism to unlock the entrance where the call is made.

D. Discreet video monitoring shall be provided to enable staff to see and hear activity from any video station.

E. The Contractor shall gather the owner's requirements prior to final configuration and furnish, install a complete turnkey system.

2.3 ACCESS CONTROL DESCRIPTION

A. The Continental Access Control System will be the main system and its database will authenticate all users of the system; additionally, it must authenticate the Trilogy Networx wireless access. The contractor shall be responsible for coordinating and integrating the authentication of the Trilogy wireless locks off of the Continental CA4K database.

B. The system shall provide card access and shall perform a variety of functions including but not limited to:
1. Access Control Management
2. Alarm monitoring Management
3. Photo Imaging/Badging Management
4. Full Audit Trail Management report
5. Personnel Tracking Management Report
6. Visitor Management
7. Advanced Scripting (Activity linking) Interface
8. Area/Building Lock Down
9. Threat Level Management
10. Automated Data Import and Data Export
11. Full Time & Attendance

C. Trilogy Networx Wireless Lock Integration The contractor shall be responsible for the configuration of the wireless locks and gateways and seamless integration with the Access Control System.

D. The contractor shall furnish and install all low voltage cable as required to monitor door positions and for door contacts.

E. The contractor shall provide 150 card fobs. They will be left blank.

F. The contractor shall provide one (1) badge printer.

G. Controller Hardware: Controller Hardware shall be of a distributed architecture nature so that in the event of server failure the local controller will make all decision utilizing both the Facility code and the unique ID and be capable of:
1. 1 to 16 card readers per panel
2. 1,000,000 card holders per panel
3. Power-Over-Ethernet
4. Card formats ranging from 26 bit to 256 bits
5. Processing data at 52 MIBS, (million instructions per second)
6. Download speeds to the controller not to exceed 6 minutes for 100,000 card records utilizing the 200 bit format
7. IPV IV and IPV VI Ethernet communications. Support AES 128/256 encryption
8. Time zone offsets
9. Reporting alarms to a central monitoring station via Ethernet without the assistance of an integrated alarm panel
10. Changing addresses of inputs and outputs for door control
11. Global I/O functions Communications of Ethernet TCP/IP, RS 232, RS -422 or a combination thereof

H. System Requirements:
1. This Host PC shall contain the ACS software GUI, Data Server, SQL database and the host communications software module. The SQL database shall be able to be located on a remote server, for improved performance. The communications software module shall be able to be located on a remote server/s, for improved performance.
2. The Host communications software shall be required to be fully compliant with Win 8.1 Pro, Win 10 Pro, Win Server 2012, and Win Server 2016 operate as a true 32-bit or 64 bit system.
3. The Host PC shall communicate with the Access Control Panels using Communication protocols such as TCP/IP, RS-422 and RS-232.
4. The ACS shall be able to support both a Database server and a Hardware Communication server either as one computer or multiple computers.
5. The ACS shall contain a total of 5 databases, with the separation of configuration, events and communication data.
6. The Card Access shall be capable of supporting a Primary server and a Secondary server for disaster recovery systems and shall not be limited by distance from Primary to Secondary.
7. The ACS workstation PC shall contain the software, the GUI, and integration executables only.
8. The ACS workstation shall have the ability to enroll card data automatically.
9. Security key or software license will be required on all Host communication server PCs in order for the system to operate. Lack of security key or software license on the Host PC will cause the communication software and the GUI to shut down. The user will be notified of the missing license by means of a popup message.
10. The Security key shall be available as either a hardware or software key.
11. Security key will not be required at workstations.
12. The Security key will determine both hardware and software limitations:
    a. Hardware License Limitations: The key will determine the number of workstations that will be able to connect to the system simultaneously.
    b. Software License Limitations: The key will determine the additional software features that a user can activate. The features will include:
        1) Max # of Hardware Communication Servers
        2) Max # of CCTV DVR/NVR Servers
        3) Time & Attendance
        4) Visitor Management Integration workstations
        5) Max # of Scripting servers
        6) Max # of Napco Integration Servers

7) API Interface
8) PIV support

I. Database Partitioning:
1. ACS shall support Microsoft SQLExpress 2008 R2, SQLExpress 2012, SQLExpress 2014, SQL 2008 R2, SQL 2012 and SQL 2014 database, and shall allow virtually unlimited database partitioning.
2. Database Partitioning shall support the ability to assign the following to individual partitions:
   a. Cardholders
   b. Controllers
   c. Workstations
   d. Card Readers
   e. I/O points
   f. Alarm Panels
   g. Access Levels
   h. Time Zones
   i. Communications Servers
   j. Dynamic Maps
   k. System Operators

J. Access Control Panels:
1. The Access Control System (ACS) panels shall support, through firmware updates, full system integration, providing full system integration to standard burglary Alarm and Fire Panels with 32, 96, and 255 Zone Control. This shall allow reporting to Police, Fire Department, and to the ACS.

2. The following latest panels shall be available:
   a. One Door Intelligent Reader POE Control Panel
   b. Two Door Intelligent Reader Control Panel
   c. Four Door Intelligent Reader Control Panel
   d. Eight Door Intelligent Reader Control Panel
   e. Sixteen Door Intelligent Reader Control Panel
   f. Expansion Modules:
      1) The ACS panels shall provide for full Supervised Alarm Input Expansion Modules (16 Supervised Alarm Inputs).
      2) The ACS panels shall support Relay Control Expansion Module (16 Form C Relay Outputs, and 8 Non- Supervised Inputs).
      3) The ACS I/O Board shall support up to 3 expansion boards, each provides 16 Supervised Inputs and 16 Relay Outputs, for a total of 48 each.

K. Additional Devices:
1. The ACS Access Panels shall support the following Add-On devices:
   a. Personnel Identification Devices, including, but not limited to:
      1) Prox-Cards
      2) Smart-Cards
      3) Key Fobs,
      4) CHUID Cards
      5) CAC Cards
      6) TWIC Cards
      7) FIPS 201-1 Cards
      8) PIV-I Cards
      9) Barcode Cards
      10) Mag-Stripe Cards

b. Access Authorization Devices, including, but not limited to:
   1) Keypads,
   2) Prox-Readers,
   3) Smart-Card-Readers and
   4) Biometric Identification devices

L. System Description:
   1. The Access Control Unit (ACU) is a fully programmable, self-contained, [16, 8, 4, 2 or 1] door system that offers users flexibility, expandability and simplicity.
   2. The system shall consist of all the hardware necessary to provide access control and alarm monitoring for all controlled entry/exit points within a single facility or multiple facilities.
   3. The system shall be a complete distributed processing system with no reliance on the host PC for any decision making.

M. The Access Control System (ACS) shall be capable of:
   1. Managing the security operations for a single site or for multiple sites.
   2. It shall consist of all the software and hardware necessary to provide access control and alarm monitoring for all controlled entry/exit points within a single facility or multiple facilities.
   3. The system shall provide full access grant or deny access authorization capabilities without the need for real-time communications with the control panels.
   4. The system will monitor alarm events and display them to the system operator for processing.

N. The system shall be designed such that entry/exit points may be added in [one, two, four, eight or sixteen door] increments.

2.4 OPERATION

A. All doors will be monitored during the school day and alerts sent if left open.

B. The system must be able to text alerts.

C. Door status must be provided.

D. The system will not be integrated to disarm the burglar alarm system.

E. Security access system shall use a single database for access-control and credential-creation functions and be configured to authenticate access to the wireless locks.

F. The contractor must configure the wireless locks (provided by others) to illuminate both sides of door (interior classroom and exterior) when the system is elevated to a lockdown.

G. Normal state all doors stay locked and closed.

H. Distributed Processing: A fully distributed processing system.

I. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.

J. Door Hardware Interface:

1. Comply with requirements in Section 087100 "Door Hardware" and Section 087111 "Door Hardware (Descriptive Specification)" for door hardware required to be monitored or controlled by the security access system.
2. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

2.5 SYSTEM SPECIFICATIONS

A. High resolution graphics:
1. The system shall support unlimited high resolution graphics with Disk-Limited and user-programmable color dynamic graphic map display capable of showing floor plan, location of alarm device, and alarm instructions.
2. The mapping software shall be able to run independent of the ACS software.
3. The independent dynamic mapping software must utilize the same database as the ACS software.
4. Floor plans shall be created in .JPG, .BMP, .PNG, .emf, .wmf or .ico formats, and can be imported from other systems.
5. All of the graphic maps will be displayed on the CPU monitor. Systems requiring separate display monitors or PC's to display the floor plans will not be acceptable. The operators must be able to perform the falling functions without use of the ACS software:
6. Add and delete devices on the dynamic maps
7. Make custom icons as devices and add to the dynamic maps
8. Open up live video on the dynamic maps by right clicking and choosing live video
9. Unlock and lock doors from the dynamic maps
10. Turn on/off devices from the dynamic maps
11. Respond to alarms from the dynamic maps
12. Add and delete dynamic maps according to permissions by operator log on
13. Utilize a Log On that is identical as the Log On given by the system administrator for the ACS with all permissions that were assigned and all restriction that were assigned.
14. All events/action shall become part of the ACS transactional history database
15. Retain "Peer Computer Control Software" Paragraph below if a single-point failure in the central station is unacceptable.

B. Information Storage: All programmed information as well as transactional history will be automatically stored onto a local or remote hard disk for later retrieval. The system will warn the operator when the database size approaches maximum capacity. The system shall be capable of using multiple ACS site databases as needed by the system users.

C. Information Archive/ Retrieval: The CPU shall be capable of transferring all programmed data and transactional history to any removable media or logical disk drive. All programmed data can be restored from disk/CD, Tape Drive etc., in case of system hardware failure. As an option, the system shall be able to offer additional support by means of a redundant mirrored system backup retrieval, for virtually instantaneous switchover in an emergency. There shall be no distance limitation for the secondary server to the primary server.

D. Communication: The system shall be capable of supporting the following communication types:
1. Serial Port type (RS232/RS422) connections
2. LAN/WAN (10/100/1000) Hard-wired & Wireless connections
3. Fiber Optics
4. TCP/IP IPV IV and IPV VI protocols

Note: A Host Server shall be able to employ any combination of the above communication types.

E. COM Port/Serial type (RS232/RS422) Connections:
1. The PC shall have a minimum of two serial ports or four USB ports for the use of USB to serial converters.
2. The system (consisting of a Host and 7 Remote Hardware Communication Servers) shall be able to support up to 2048 Com ports, each Hardware Communication Server supporting 256 Ports. In case all of the 256 ports are to be used for serial communication, you need to employ Com Port expansion cards. Each expansion card will be able to provide expansion in increments of 32 Com Ports.
3. Each com port will be able to support hard wired direct connect or modem connections. An additional 256 ports per Host or Hardware Communication Server can be used for modem specific ports, for up to 512 total ports.
4. Each COM port must be able to have password protection as an option.
5. The system operator will be able to enter a password for each COM port.
6. When operating in this mode, the ACS door controllers will not accept communications from any host PC, workstation or communications server that does not provide the correct password.
7. The system operator will be able to individually assign this password to selected panels.
8. The COM port password will be encrypted both in the system database and in the Access Control Panel.

F. LAN/WAN (10/100/1000) & Fiber Optics Communications:
1. The Host PC shall support LAN (local area connection).
2. The system (consisting of a Host and 7 Remote Hardware Communication Servers) shall be able to support up to 2048 LAN ports, each Hardware Communication Server supporting 256 LAN Ports.
3. Each port shall support typical Cat 5 LAN Connection or Fiber Optics LAN connections.
4. Each LAN port shall be able to have password protection.
5. The system operator will be able to enter a password for each LAN port
6. When operating in this mode, the ACS door controllers will not accept communications from any host PC, workstation or communications server that does not provide the correct password.
7. The system operator will be able to individually assign this password to selected panels.
8. The LAN port password will be encrypted both in the system database and in the Access Control Panel.

G. Printers: The system shall support page printing of reports by any page printer that can be installed, configured and supported by the Microsoft Windows ® operating system. The system shall also support printing of alerts or any events above a user selected priority.

H. Mouse: The ACS shall use USB or Wireless mouse configured under and supported by the Microsoft Windows ® operating system.

I. Workstations: The system shall support up to 500 additional active remote workstations. These stations shall be capable of monitoring alarms, running CCTV Integration, DVR Integration, Alarm and Fire panel integration, Scripting, Video Badging, Time and Attendance and Visitor Management. Video Badging Full integration shall use the same SQL database and hence no multiple entries will be needed. The ACS Management software shall overlook all database administrative tasks, of all system workstations including:
1. Access control management
2. Alarm monitoring management
3. Photo Imaging/Badging Management
4. Visitor Management
5. Conditional Badging Management
6. Muster System Management

J. Networking: The system shall provide networking operation via local area networks (LAN) or Wide area networks (WAN), both wired and wireless (802.11g standard), using the standard features of Microsoft Windows ® networking software.

K. Licensing: The ACS shall offer you the following licensing options:
1. The system shall provide one Server license.
2. Client/user workstation licensing for [5, 10, 25…and up to 500] workstations shall be available as an option.
3. Additional licensing for up to 7 additional Hardware Communication Servers shall be available as an option.
4. The system shall support concurrent usage of all system workstations as per the license limitations. System operators will be able to perform independent functions on each workstation. The system allows access to only one particular table for additions, deletions or editing, one user at a time.

L. Database:
1. The database shall be Microsoft SQLExpress 2008 R2/2012/2014 (Database Engine) or optionally Microsoft SQL Server 2008 R2/SQL Server 2012/SQL Server 2014.
2. It shall be scalable. Systems initially installed using Microsoft SQLExpress 2008 R2, shall be field upgradeable to Microsoft SQL Server 2012/SQL Server 2014.
3. The database will fully integrate with the Government PKI database for validation of a card and automatically remove access privileges when the card holder information is moved to the Government Revocation list.

M. Access Control Panel: The Access Control Panel system shall be scalable and operate efficiently over a wide range of facility sizes and applications. Systems utilizing a remote module at the door that reports back to the controller will not be accepted. The Access Control Panels shall be capable of:
1. Entry/exit points will be able to be added without the need to replace any system hardware or controllers.
2. Controllers may be selected and added in increments of [1, 2, 4, 8 or 16] door configurations to provide the maximum flexibility and cost effectiveness.
3. Distributed, intelligent, fully independent controllers will be able to be used to provide fully distributed decision and authorization capabilities.
4. In the event the host PC cannot communicate with any/all controllers, no degradation in security shall occur.
5. Reading multiple cards formats simultaneously with no degradation of “time to unlock”.
6. Multiple reader formats/readers shall be read at a single controller simultaneously.
7. Reading bit structures from 26 bit to 256 bits.
8. Storing up to 1,000,000 card holder records.
9. Reading the FIPS-201-1, PIV, PIV-I, TWIC and CAC card formats.
10. Shall be capable of Time Zone Offsets for those panels deployed in different time zones.
11. Unlock times not to exceed .5 seconds after a valid card read.
12. Download speeds to be at 921 kbps allowing for 40,000 cards to be downloaded in less than two minutes.

2.6 SOFTWARE CAPACITIES

A. System software and language development software exist, and are industry accepted, allowing the customer to choose the Language desired by the user. There can be full customization of the following:
1. Software GUI Screens containing multi-tab selections.
2. Icons .

3. Custom Icons to launch third party applications
4. Communication messages, and Reports.
5. The Operating system shall be 32 or 64 bit multi-user / multi-tasking capable of operating in a non-proprietary CPU.
6. The application software shall be written in a standard, industry accepted language. All System functions shall be accessible via Microsoft Windows ® compliant menu-accessed screens. Systems requiring command string control or complex syntax will not be acceptable. Systems shall not be dependent upon external input, other than keyboard.

B. Each system shall be capable of supporting:
1. Over 2000 Serial/LAN Communication Ports and over 4000 Ports Total.
2. Over 32,000 Readers.
3. Unlimited Cardholder database (SQL Version-limited only to Hard drive capacity).
4. 500 Workstations.
5. 255 Time Schedules each w/least 10 start/stop intervals.
6. 5 Holiday types with 100 user-definable holidays each (500 Total).
7. Unlimited System operators.
8. 30,000 access levels per panel.
9. Over 256,000 supervised inputs.
10. Over 256,000 relay outputs.
11. Over 16 thousand global link (output) programs.
12. Up to 10 facility codes per Access Control Panel or 100,000 system facility codes per panel with Facility Code/Badge Concatenation.
13. Unlimited operator passwords with definable privilege levels.
14. Unlimited .wav files for alerts
15. Unlimited color dynamic graphic maps.
16. Unlimited RS-232 interface ASCII commands to a CCTV system, which provides automatic, alarm activated camera switching, and Live Camera image Capture.
17. Unlimited number of floors for Elevator Control.
18. Cardholder activation/cancellation dates.
19. Unlimited number of CI Scripting(linking) Servers.
20. Unlimited number of Napco Alarm Servers.
21. Unlimited number of Time Zone Offsets.

2.7 SYSTEM SECURITY

A. Password: The system software shall be capable of identifying unlimited temporary or permanent operators. Passwords may be up to 20 alphanumeric characters, and will be case sensitive requiring at least one upper case character and at least one number.
1. Password Security: Permanent passwords will be able to be provided only by the operators. The administrator may only provide a temporary one-use initial password, which must be changed by the operators, when they log on. Operators will be allowed to change their passwords any time. Operator password invalidation will be required in cases of suspected operator security breach (which can occur when the operator is not on site or is otherwise unable to logon) in order to enforce immediate change of password. When an administrator adds a new operator, the concerned operator's password may not be left blank and must be set to a temporary value that can be used only once. When a temporary password has been provided by the administrator, the New Password dialog will be displayed after the temporary password has been entered.
2. An operator record will be required to have a unique name, to allow the use of same passwords by different operators. If duplicate passwords are not allowed, security can be compromised. For example, a 'password already in use' message will reveal one of the existing

passwords, which is of course a security violation. No secret information is revealed by saying, 'Operator name already in use, please enter a different name'.

3. The system administrator will have the capability to require an operator to change his/her password. The system administrator may invalidate the operator's password. The operator will then be required to provide a new password during his next logon.
4. System Operators will have the ability to change any workstation settings, from whichever station they are working on.
5. The system administrator may assign an operator to a group. As a result, the operator will be able to view/ change and create items that are assigned to the particular group only.
6. The system will record in the Audit Trail database, the time at which an operator logs into/out of the system, as well as any changes that were made by the user during login.
7. The system will support Single Sign-on utilizing LDAP and Active Directory.

B. System Operators:
   1. Privilege levels: Each operator will be able to be assigned any combination of up to 100 user programmed privilege levels. Operator Control will be limited by the following access rights:
      a. Disable
      b. View Only
      c. Create Only
      d. Create and Edit
      e. Edit only

C. Personnel Database Security: The system administrator will be able to restrict each operator's privileges to View, Create, Edit Only or Create/Edit each field in the Personnel database.

D. Audit Trail of Database Changes:
   1. The system shall record changes to the database, including the date, time, operator name and description of the record changed.
   2. The audit trail shall track event messages record additions, deletions and revisions. The record will contain a date/time stamp for the change, the logged on operator's name, table name, action identifying the change, and a description based on the 'Name' field of the record such as, user name, operator name, panel name, reader/door name and workstation where the change was made.
   3. The system shall allow for browsing of Audit Trail. The dialog box will contain a database grid component that will display the records of the Audit Trail Table.
   4. The system shall NOT allow the Audit Trail table to be edited.

2.8 SOFTWARE SPECIFICATIONS

A. The system shall have the capability to integrate with various facility management functions such as:
   1. Burglar and Fire Alarm Panel
   2. Visitor Management
   3. HR interfaces
   4. Government PKI databases
   5. Time and Attendance
   6. Asset Tracking
   7. CCTV DVR recording devices so that, all available functions may be controlled from any ACS workstation connected to the network

B. The system shall be capable of handling large multi-site corporations across Local (LAN) and Wide Area Networks (WAN) while utilizing AES 128/256 bit encryption.

C. The system software shall be true 32/64 bit software.

D. The system shall support both Microsoft SQL Express 2008 R2/2012/2014 and Microsoft SQL 2008 R2, SQL 2012 and SQL 2014. Microsoft SQL Express is the system default.

E. The system shall support multiple languages offering the following privileges.

F. The system shall support multiple credentials per badgeholder.

G. The system operator will be able to select the desired language from a pull down list of available languages.

H. The system shall be able to remember individual operator settings and automatically switch to the appropriate language for the logged on operator.

I. The system shall support use of different languages at each workstation.

J. The system shall be capable of switching between languages without the need to re-boot the system.

K. Communications: In addition to the normal hardwired configurations, the system shall allow selection of all modes of polling, (LAN/WAN, Hardwire, Wireless network, and Dial up) if needed from one single host server, allowing for a combination of polling modes. The System shall allow full flexibility of controller polling from the Host server, and also shall allow an additional Remote Hardware Communication Server (Network LAN/WAN) for remote polling. The system shall support the following alternative communications modes:

1. Network:
    a. All communications shall be capable of AES 128/256 bit encryption
    b. The system shall have the capability to communicate with system controllers from the Host PC on the network via a Local (LAN) or Wide Area Network (WAN). Multiple communications servers may be run concurrently within the system utilizing AES 128/256 bit encryption.
    c. Controllers communicating over a network via LAN/WAN will be able to be password protected.
    d. Controllers shall have the capability of having two Ethernet connections. One being primary and one being secondary for redundant communications paths.
2. Dial IN/OUT:
    a. When operating in dial mode, the system shall automatically download to the controllers any changes that may be made to the configuration or operational databases.
    b. It will be possible to schedule uploads and downloads in accordance with the following schedules. The modes may be mixed.
        1) By schedule: At any time a schedule previously programmed into the system may be used to initiate a dial-out to the controller.
        2) On The Hour: A dial-out may be automatically initiated each hour, on the hour.
        3) Twice Daily: Dial outs to the controllers may be initiated twice daily, one at Noon and the other at midnight.
        4) Daily: A dial out may be initiated each day at noon-time.
            a) It will be possible for the system operator to initiate a manual dial out connection to any controller connected via telephone line, at any time.
            b) Controllers connected to the system via telephone lines may initiate dial in connections to their host PC in case they detect alarm events that have been previously programmed as high priority events.

c) Controllers connected to the system via telephone lines may initiate dial in connections to their host PC in case the controller (Access Control Panel) transaction buffer is 75% full.
d) Controllers being communicated with over telephone lines will be able to be password protected.
e) The system shall support a minimum of two dial-out lines.
f) The system shall support a minimum of two dial-in lines.

2.9 SYSTEM SOFTWARE FEATURES

A. Anti-Pass back:
1. The system shall support the following modes of anti-passback:
a. Global System Wide Anti-Passback: The user may enter at any IN reader and/or leave using any OUT reader in the system. Up to 250 + Anti-Passback areas shall be supported.
b. Hard Anti-Pass back: The cardholder will not be able to use his/her card consecutively at either an In or an Out reader. Doing so will generate an event message and the system will deny access to the cardholder. The cardholder must be In before swiping Out, and vice-versa.
c. Soft Anti-passback: Will allow the cardholder to access an (In) or (Out) door consecutively, but the system will generate an error message.
d. Duration Use (timed) Anti-Passback: The system shall have the capability to restrict the use of an In or an Out reader for a particular card-holder, for a certain duration of time. When applied to an APB type reader, this duration will determine the amount of time (minutes) that a badge that is in APB violation, will be rejected. If a badge is rejected due to APB violation, the use of this badge in the same direction-type reader will continue to be rejected until the duration use time expires. After the expiration, the badge holder will be permitted passage at the reader.
e. Nested Anti-Passback: The system shall support multiple zones of anti-passback within the same building I.E. Independent zones of anti-passback where one in read from one zone does not affect another zones setting.
f. APB Reset: The system shall be capable of a global reset of all cardholders in the system. This can be done by schedule, or manually.
g. Nested Anti-Passback: The system shall be capable of nested anti-passback.

B. Dedicated Access:
1. The system administrator will be able to assign one or more readers to Badgeholders individually.
2. The personnel database supports the assignment of unique groups of doors and time schedules to each badge holder.

C. Database Partitioning:
1. The system shall support partitioning of database. System administrators will have the capability to restrict operators from viewing, adding, editing or deleting data, or system configurations.
2. The system shall support the assignment of multiple operators to the same database partition.
3. Database Partitioning should allow the administrator to assign each Operator Privilege to the followings folder tabs:
a. Forms Control: This tab shall provide access to all system database menus and menu items dependent on operator privileges. The menus and their items at minimum are:
1) System
a) Language
b) System Settings
c) Achieve/ Restore

d) View History
e) Audit Trail

2) Control
   a) Doors
   b) Relays
   c) Links
   d) Activity Links
   e) Napco Panels
   f) Schedule Changes

3) Access
   a) Personnel
   b) Badge Holders IN (Muster)
   c) Lockdown Areas
   d) Access Groups
   e) Find Usage

4) Administration
   a) Badge Formats
   b) Facility Codes
   c) Schedules
   d) Holidays
   e) Operators
   f) Threat Level Management
   g) Photo ID

5) Operators
   a) Operators Privilege
   b) Operators Response
   c) Operator Instructions,
   d) Operator Instruction Links
   e) Maps

6) Configuration
   a) Panels
   b) Readers
   c) Inputs
   d) Relays
   e) Links
   f) Activity Links
   g) Com Server and Ports
   h) Shunt Groups
   i) Modems
   j) DVR server
   k) Napco Server
   l) Scripting
   m) Central Station Reporting

7) View
   a) Stations
   b) Status
   c) Pending Alerts
   d) Events

8) Help
   a) CA4K™ Help
   b) Documents
   c) About CA4K™

9) Alert Signal Menu
   a) Silence
10) Control Menu
   a) Control Devices
11) Status Menu
   a) Remove Entry
12) Remove Station Menu
   a) Remove Off- Line Workstation
13) Personnel Fields Control:
   a) Batch Modify
   b) Access Time
   c) Access Group 1-16
   d) Access Group Expire Dates
   e) Access group template
   f) APB In
   g) APB Out
   h) APB Exempt
   i) APB Set Next
   j) APB Settings
   k) Activation Date
   l) Badge Number
   m) Badge Photo Type
   n) Capture Signature
   o) Company ID
   p) Department
   q) Duration Use
   r) Embossed
   s) Enabled
   t) Escorted
   u) Expiration Date
   v) Facility Code
   w) First Name
   x) Group
   y) Hire Date
   z) Initial Download
   aa) Last Access
   bb) Last Name
   cc) License
   dd) Location
   ee) Phone
   ff) Phone Extension
   gg) Photo Modify
   hh) Photo Import
   ii) Photo Preview
   jj) Photo Print
   kk) Photo Export
   ll) Clear Photo
   mm) Clear Signature
   nn) Pin (Keypad Pin Number)
   oo) Print Photo Copies
   pp) Re-Issue
   qq) Remarks & Note Field

rr) Shunt Group
ss) Shunt by Reader
tt) Shunt Inactive
uu) Shunt Shunting
vv) SSN (Social Security)
ww) Stay On Panel
xx) Supervisor
yy) Tracked
zz) Badge Use Limit
aaa) User Field 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 thru 48
bbb) Vehicle Tag
ccc) Dedicated Access Group Name
ddd) Dedicated Access
eee) Dedicated Access Group Assignment
fff) Vehicle

14) Database Partitions: This tab should allow partitioning of all system database Partition groups below but not limited to:
a) Personnel Partition Group
b) Panels/Door Controllers Partition Group
c) Readers Partition Group
d) Time schedules
e) Alarm Inputs Partition Group
f) Relay Outputs Partition Group
g) Links (If Than) Macros type Partition Group
h) Access levels Partition Group
i) Time Schedules Partition Group

D. Event Printing: The system shall support printing of alerts or any events above a user selected priority.

E. Printer Types: The system shall be capable of supporting three types of printers.
1. Report Printers: Reports requested by the operators will be sent to these printers. These printers may reside anywhere on the network.
2. Event Printers: Individual events will be routed to any of the event printers in real time.
3. Dye-sublimation Video Badging type of printer: These can be single/double sided printers. The system software shall support many different printer driver manufactures, and will be compatible with any of the following Continental Access printer models:

F. Scheduled Reports:
1. The system shall be capable of running unattended scheduled reports, automatically. Operator intervention shall not be required.
2. The system shall support the creation of report templates. These templates will be saved by the system for repeated retrieval and use by the system operators.

G. Badge Validator (Enable/Disable):
1. The system operator will be able to program a reader as a ‘Badge Validator reader. Badges presented to this reader are automatically enabled or disabled on consecutive card swipes.

H. Auto Acknowledge Priority Set Point:
1. The system operator will be able to set a priority level between 1 and 99 as an automatic acknowledge point.
2. All alerts that have been assigned a priority lower than the set point will be automatically acknowledged by the system.

3. The system operator will be able to easily modify this set point as well as, enable or disable it.

I. Partition Groups:
1. The system administrator will be able to perform manual control based on Partition groupings of Personnel, Panels/Controllers, Readers, Inputs, Relays and Links.
2. The system administrator may assign one or all of these items to named Partition groups. The system operator will be able to select any/all of these items by selecting the name of the desired Partition group, and perform system functions in a 'batch mode' on all of them.
3. The system administrator may partition the system using Partition Groups.

J. Access Group Templates:
1. The system administrator will be allowed to select any existing access group and use that group as a template for creating a new similar access group.

K. Default Relay and Input Assignments:
1. The system shall provide default settings for relay and input assignments. This default programming will be populated each time a reader is programmed.
2. The system shall allow the operator may choose to modify these default settings as required.

L. Import:
1. The system shall support importing of personnel data from other databases.
2. The system shall be capable of recognizing any flat file that contains ASCII data.
3. The operator will be able to select the field separation character.
4. The system shall support importing of Active Directory Users (LDAP).

M. Export:
1. The system shall support exporting of all system events. The operator will have the option of selectively exporting any/all event record types.

N. Auto Import/Export:
1. The system shall support automatic import/ export of data to and from the ACS database. The system operator may set up specific files to 'import (from)' or 'export (to)'. These files may be on a local drive or network drive.

O. Elevator Control:
1. The system shall be capable of controlling access to building elevators by making use of Access Groups and relays.
2. The system shall be provide an Elevator Control software interface.

P. Archive and Restore of Data:
1. Data Archive:
a. The system shall allow archiving of the data required to configure the system. The operator will be able to choose to archive all configuration data or, selectively back up this data by category.
b. The operator will be able to archive events as well. The entire Events data will be able to be archived or, only select event types can be backed up based on a period of time.
c. The system shall offer the option of storing the archived events/configuration data in the local database or, in a database present on a remote site.
d. The operator shall be capable of setting up archive database backups by a schedule for automatic backups.

2. Data Restore:

a. The system shall allow restoration of all previously archived data. The operator will be able to restore all configuration data or, restore only select data by category.
b. The system shall allow the administrator to restore data from any location where an archive was previously done, and will still be available to the system via network connection.

Q. Scheduled Changes:
1. The system shall be capable of scheduling time changes to Readers, Inputs, Relays and Links, automatically. The system will be able to execute these scheduled changes without the need for operator intervention.
2. The system also shall provide the operator the flexibility to control the scheduled change by a single device or a 'Group' of devices.
3. The system operator may program these changes for the current year or any year in the future that the operating system can support.

R. Badge Holders IN (Muster List):
1. The system shall be capable of providing a list of all badge holders currently logged as IN the building.
2. The list shall include the Name, Location and Time of the badge holders' last IN transactions.
3. The default readers for this list shall be all readers. The operator will have the privilege of selecting any reader in the system for the list, provided, the reader has been programmed to report 'In' and 'Out' events.
4. The operator shall be able to print a report of this list directly from the Badgeholders IN screen to any printer on the system or it can be generated automatically in response to an event or input.

S. Find Usage:
1. The system shall enable the administrator.
a. To determine the time schedules and access groups that will be contained within a particular Access Control Panel.
b. To determine the exact counts of badges, access groups and time schedules that will be contained within a particular Access Control Panel.
c. To determine the presence of any Time Schedules or Access Groups that will no longer be used by the system.

T. Badge Formats:
1. The system shall accommodate various badge data formats, simultaneously, by allowing the system operator to enter into the system, the information about the data contained within a particular badge.
2. The system shall support multiple badge formats, simultaneously.
3. The Badge Format function shall support American Banking Association (ABA), FIPS 201-1, PIV, PIV I, CHUID TWIC and Wiegand data formats.
4. The system software shall have the capacity to download a minimum of ten (10) user defined badge formats to each panel. These formats will allow for the use of several card technologies, simultaneously. Alternately, the system shall support 100,000 system facility codes per panel with Facility Code/Badge Concatenation.

U. Alarm Monitoring Management and Alert Processing:
1. The system shall support 99 levels of alert priority. The system administrator will be able to assign these priorities uniquely to any alert or event in the system.
2. The administrator may partition the events by user. Only events from the panels and readers in the operators' partition will be viewable.
3. Each priority will be uniquely identified by color that is hard-coded in the software.

4. The alert display screen will be divided into two sections.
   a. Those alerts requiring intervention by the system operator will be placed in the 'Pending Alerts Grid'. These events will remain in the Pending Alerts grid until such time the operator makes a determination, or the system Auto-Acknowledge function determines that the event should be automatically acknowledged by the system. When an event is auto-acknowledged, the system will append to the event record the date and time the event was auto-acknowledged, the operator that was logged on, and an indicator that the event was auto-acknowledged.
   b. Alerts not requiring operator intervention will be placed directly in the 'Events Grid'. The Events grid allows the operator to view the current and past events.
5. The system administrator will be able to force the operators to enter a response for each event the operator processes. The administrator may predefine response messages which the operator may choose from, or the operator can enter his/her own response.
6. The Events grid will contain button controls for sorting and viewing of events. The buttons will be:
   a. Recent: This button will display the most recent / latest events. (This can be set per user).
   b. Browse Mode: Once the user has logged in, the system shall automatically put the Events grid in Browse. This mode will 'freeze' the event screen for browsing.
   c. Previous/Next: When sorting on a header there will be two buttons (PREVIOUS) and (NEXT). The Previous button will display the previous day's transactions. The Next button will advance you to the next day's events.
   d. Photo/Map: If the Photo/Maps option is enabled, the system should automatically display each user's photo and/or map.
7. Each alert record will provide the following information:
   a. Class, Description, Location, Date, Priority, and Operator that acknowledged the alert and the time it was acknowledged either through the ACS software or the ACS stand alone map software directly on the Map.
8. Alarm Description: Each alarm point may be defined with a plain text description of up to 40 characters.
9. Alarm Enabling: Alarm points will be enabled during user-definable time schedules and they can be manually silenced from any workstation.
10. Additional Alarms: The system shall also generate alarms for the following:
    a. Enclosure tampering
    b. Access Control Panel communication loss/restore
    c. Alarm tampering (supervised)
    d. Alarms shall be capable of utilizing events generated by the ACS software.
11. Alarm supervision: When using supervised alarm points, the system shall monitor for "OPEN", SHORT", and "GROUND FAULT" in addition to NORMAL/ABNORMAL conditions.
12. ASCII Output-CCTV Remote Control
    a. Alarm points will have the capability to output an ASCII text command for CCTV switched interface.
    b. This command/output will be user-definable and transmitted on alarm points going into abnormal state, returning to a normal state, or both, and for specified reader events as well.
13. Maps/Floor Plan Assignments
    a. The system operator will be able to choose to assign a floor plan to each alert/ event. This floor plan will help in showing the exact location of the event. The system shall be capable of displaying these floor plans automatically or manually by the operator.
    b. If the event is a badge event, in addition to the floor plan, the system will be able to automatically or manually display an image of the badge holder both from the database and live from the CCTV interface.

c. The system operator will be able to choose to disable the floor plans function in case it is not being used.
d. The maps shall be capable of running without the ACS software running.
e. The system operator shall be able to assign icons to devices such as:
1) doors
2) card readers
3) Cameras
4) Alarm points to include perimeter protection systems
5) Controllers
6) Automatic gates
7) Any device that is controlled by the ACS
f. The system operator shall be able to, from the map software
1) Acknowledge alarms
2) unlock doors
3) pull up live video from any camera
4) open automatic gates

14. The system operator will be able to acknowledge pending alerts one at a time or automatically acknowledge all pending alerts.
15. The system operator will have the advantage of filtering events to display only the category of interest.
16. Event display modes:
a. Tracking Mode will allow the operator to view events activity displayed on the screen as they occur.
b. Browse Mode will prevent the incoming events from scrolling on the screen. The highlighted event the operator wishes to dwell on will remain stationary on the Events grid. All events may be sorted alphanumerically.
17. Manual Control will be available for every event, which appears in the Event or Pending Alerts Grid display that relates to a door, relay or link.
18. The operator will be able to quickly sort event records by clicking on the column header above the record field he wishes to sort by.

V. Web Browser interface
1. The web browser shall be able to be used remotely and allow for all programming functions offered by the ACS software.

W. Scripting
1. The ACS software shall have a scripting GUI that allows for:
a. automatic lock down of all doors
b. send e-mail messages on events or alarms
c. attach events to linking alarms
d. attach alarms to linking actions
e. automatically arm and disarm the Intrusion Detection System
f. disable any or all card readers
g. Choose an individual card or input to automatically perform and event when the card is presented to a reader/s or the input goes active in a normal or abnormal state.

X. Continental FIPS 201, PIV-I,TWIC, FRAC & NIST 800-116 Credential Validation with the CoreStreet Approach
1. Continental Access System shall be capable of PIV and PIV-I enabling to the CA4K™ software as to validate the card with the Government PKI database and the TWIC Hot List database. This function shall be done at the database on every cardholder within the system at the time of enrollment with checks, no longer than 18 hours, of the revocation list.

a. The checks that shall be accomplished are:
   1) Path discovery – The path from the PIV certificate to an embedded trust anchor.
   2) Path signature verification – establishing that every certificate in the path is genuine and not counterfeit.
   3) Data object signature verification – establishing that every signed data object on the card was signed by a trusted issuer (e.g. certificates, fingerprint template, facial image template) to ensure they are genuine and not counterfeits.
   4) Cross checking data object identifiers – all signed data objects on the PIV card have an identifying number (FASC-N) unique to that card. Checking that each data object contains the same FASC-N (or CHUID) ensures they all belong to the same credential.
   5) Various PKI conformity and freshness checking (key usage, expiration dates, etc.)
   6) PIN check –to ensure the card holder is bound to the credential to mitigate the threat of lost or "shared" cards.
   7) Private Key challenge – to ensure the certificate is bound to the token to which it was issued and has not been copied or cloned.
   8) Biometric check – to ensure the card holder is the same person that was issued the PIV card. This mitigates the threat of "shared" cards and disclosure of the card's PIN.
   9) Periodic checking of the revocation status of the PIV Authentication certificate.
   10) Periodic revalidating the full path – to ensure all of the certificates in Access Control database remain valid and have not been revoke.

2. Validation during enrollment shall include all of these checks to ensure at the highest level possible that all enrollees are in fact who they claim to be. This would typically be done as a function at or in conjunction with the PACS head-end.
3. Validation at the time of access shall involve a subset of these checks depending upon the assurance level required and authentication mechanism chosen for the specific access point being addressed.

Y. Hardware Definitions:
1. Menu configurations: The System software shall allow for the configuration and programming of the Access Control Panel through the use of a simple graphical user interface (GUI).
2. Access Control Panel Memory Allocation: The allocation of memory for cardholder data, event storage, time schedules and access groups within each Access Control Panel will be user-definable from the 'Configuration' menu.
3. Auto-Baud: The system shall allow for advanced baud rate 'syncing' capability with all Access Control Panel's on the system.
4. Auto Panel Type detection:
   a. The system will be capable of determining the type of panel (Access Control Panel) that is connected to a given COM port.
   b. The system shall automatically populate this information in the database.
   c. The system shall limit the number of readers to be programmed based on the panel type.

5. Interactivity:
   a. The system software shall allow, through the optional use of interactivity, less frequently used cardholder records to be automatically stored at the host CPU rather than the Access Control Panel in order to optimize Access Control Panel memory space.
   b. The system operator will be able to configure an Access Control Panel to operate in Interactive mode. When operating in this mode, if an invalid badge is presented to the reader, the panel will query the database to determine if the badge holder is valid in the host database. If so, the data will be sent to the Access Control Panel and an access grant/ deny decision will be made by the Access Control Panel.

6. Access Control Panel Nodes: The system software shall allow up to 512 nodes of Access Control Panels. All of these nodes will be capable of dial-Out communication. A Node will consist of one COM Port with up to two (2) modem connections to support both incoming and outgoing connections. Therefore, you will be able to have two nodes for each COM port.
7. Database Updates: The system software will be able to automatically download/upload information to the Access Control Panels while the Access Control Panels are in communication with the host CPU. A data download will be able to be initiated manually also.
8. Workstations: The system software shall be capable of reporting selectable data by type and by time schedule to any combination of the system workstations simultaneously.
9. Serial Ports: All serial ports will be able to be configured from an easy- to follow menu. Serial ports will be user friendly and selectable for Modem or Cable users, allowing Baud Rate select, and password for each Serial port. Systems requiring in depth knowledge of the operating system or CMOS setup for port configuration are not acceptable.
10. LAN Connections: All LAN Connections will be able to be made from an easy to follow menu.

Z. Time Schedules:
1. Setup: The system software shall have the capacity for 255 user-definable time schedules. Each time schedule will allow for a maximum of 10 individual time intervals.
2. Assignment: The time schedules will be able to be assigned to:
   a. Cardholders
   b. Inputs
   c. Outputs
   d. Doors
   e. Link Programs
   f. Activity Link Programs
   g. Schedule Changes: Readers, Inputs, Relays & Links
   h. Access Groups

AA. Holidays: The system software shall support a minimum of 5 sets of 100 holidays. Holidays are considered as the eighth day of the week, and have different user-definable parameters from the normal designations for that particular day. A holiday will be capable of starting at any time/hour during a 24-hour day. Systems requiring holiday start time of midnight are not acceptable.

BB. Door Definitions:
1. Door Descriptions: Each door shall have a user-definable description of up to 40 characters.
2. Anti-Passback: The Anti-Passback feature shall have the capability of doing nested anti-passback. Each door may be assigned any one of the Anti-pass back states mentioned below:
   a. IN
   b. OUT
   c. NEUTRAL
3. Reader Modes: In addition to the normal mode, each reader will be able to be programmed to respond in the following modes:
   a. ESCORT: Visitors or non-supervisory personnel may only gain access after presenting a valid card, followed by an authorizing cardholder presenting his/her card.
   b. TWO-PERSON: Two valid card reads will be required for access.
   c. DURATION-USE: A user-definable time period may be set to reject successive card reads by the same cardholder.
4. Access Modes: Each door may be programmed to switch automatically between the following modes of operation, based on a user defined time schedule:
   a. CARD ONLY
   b. CARD + PIN
   c. FREE ACCESS

d. COMMON 4 DIGIT KEYPAD ENTRY
e. CARD OR CARD # THRU KEYPAD

5. Duress: If a reader is operating in "CARD + PIN" mode, the duress feature will allow an alternate code to be entered into the keypad for access. The system will then generate an alert that may be linked to control relays for the notification of the duress alarm.
6. Door Alarms: Each door may be programmed to generate FORCED DOOR and DOOR OPEN TOO LONG alarms. These alarms will be able to be allowed to have a time delay as required.
7. Door Alarm Annunciation: In addition to generating an alarm message, the following conditions may activate an output for annunciation:
   a. FORCED DOOR
   b. DURESS
   c. DOOR OPEN TOO LONG (DOOR AJAR)
   d. VOID CARD
   e. DENIED CARD
   f. ANTIPASSBACK
   g. INPUT DOOR ALARM
   h. TAMPER
8. Card Data: The system software shall allow for card numbers up to 19 digits.
9. Facility Codes: The system software shall allow for up to 10 facility codes per-panel to be used in the system simultaneously. All 10-facility codes can be downloaded to the Access Control Panels to function in a stand-alone mode, with or without the PC. Alternately, 100,000 system facility codes per panel with Facility Code/Badge Concatenation shall be supported. Systems supporting only one (1) facility code will not be acceptable.

CC. Cardholder Database:

1. The cardholder database will contain all information required to control the cardholders' access to the facilities.
2. The system administrator will be able to restrict a system operator's privileges to disable, view-only, create-only, and create/edit.
3. Cardholder Records: Cardholder records will consist of a minimum of the following:
   a. Card Number: The actual badge number assigned to the badge holder.
   b. First and Last Name
   c. Issue level: This indicates the number of times a particular badge number has been issued to a badge holder.
   d. Up to (16) Access Groups: Each badge record will be able to be assigned up to sixteen access groups.
   e. User-Definable PIN Code: A badge holder will be able to select his/her own PIN code. The PIN code must have a minimum of 1 digit and a maximum of 9 digits
   f. Facility Code: The system shall be capable of accommodating various facility codes within the system. A badge holder will be able to be assigned one of the ten available facility codes.
   g. Anti-Passback Location and Status: This field shows the badge holder's current anti-passback status, Exempt from APB, In or Out, and the last In/ Out door they were allowed to enter or exit.
   h. Activation Date: The system administrator will be able to enter a date in this field to enable the concerned badge automatically.
   i. Expiration Date: The system administrator will be able to enter a date in this field to disable the concerned badge automatically.
   j. Badge Use Limit: The system administrator will be able to limit the number of times a badge holder can use his/her badge. In order to do this, the administrator needs to enter a number from 1 to 999 into the Badge Use Limit field.

k. Photo: The system shall permit importing of existing photos or capturing new photos of the personnel, into the cardholder database. The administrator will be able to configure the system such that, presentation of a badge will display the concerned badgeholder's image, in the personnel record.
l. Track Status: When this field is checked, the system will display an event message regardless of any other system setting(s).
m. Last Valid Access: This field will display the last reader, location, date & time at which the particular badge was last used.
n. 48 User Definable and Searchable Text/Data Fields: The system shall include a minimum of 48 user fields divided into 4 tabs in the cardholder database. These fields can be employed for searching personnel records.
o. Duration Use: When this field is checked, the badge holder will not be able to gain entry through an APB reader for the specified duration use time. The duration use time will be variable and will be able to be set by the system operator.
p. Escort: When this field is checked, any badge holder flagged as Escort required, can gain access at the concerned reader, only when accompanied by a non-escort badge holder. The badge holder being 'escorted' will have to present his/her badge prior to the escorting badge holder.
q. No transaction will be generated until both badges are presented at that reader. A time limit will apply between the two badge swipes.
r. Extended 'Access Time' (for ADA Compliance): When checked, the badge holder shall be allowed an extended amount of time to gain access through the door. The system operator will be able to fix any length of time up to 255 seconds.
s. Anti-Passback Override: The system shall allow the system operator to exempt individual badge holders from the anti-passback rules.

4. Batch Modify: The system software shall allow groups of cards to be created/modified by using a card number range.
5. Searching: The system shall allow the operator to quickly find cardholder records by clicking on field titles and entering the criteria being looked for directly into the data field.
6. Alarm Shunting: The system shall facilitate shunting of alarms by allowing certain badge holders to shunt an input/ group of inputs automatically, on presentation of the concerned badge, at a reader.
7. Extended Shunt: If a shunt card is presented at an alarm shunt reader, the value of the Shunt Timeout will be used to determine how long, in minutes & seconds, the door may be opened before a "Door Open Too Long" alert is sent to the host PC.

DD. Reports:

1. Report Types: User-definable data reports will include, but are not limited to, the following information:
   a. Cardholder data
   b. Events
   c. Alert responses
   d. Access Groups
   e. Links
   f. Activity Links
   g. Facility Codes
   h. Holidays
   i. Hardware
   j. Time & Attendance
   k. Operators
   l. Time Schedules
   m. Operators

n. Badgeholders In (Muster List)
o. System Settings
p. Audit Trail
q. System Health

2. Transaction Reports: Transaction reports will be available for the following:
   a. Card transactions
   b. Alarm transactions
   c. Event transactions
   d. Operator activity
3. Search Criteria: The database shall be structured such that the operator can determine the search parameters based on variables available on the individual report menu. Systems requiring the user to type complicated search strings will not be acceptable.
4. Hardware Report: The system shall have the capacity to generate one comprehensive report that shows the exact configuration of all installed and programmed hardware.
5. Export Report Capability: The system shall support the export of custom reports to Excel, HTML and/or Text file data types.
6. Badgeholders IN (Muster) Report: The system shall support the Badgeholders IN report to be run automatically with the use of an Input.

EE. Help Screens:
1. Online help: The system software shall have online help available at any point requiring operator input. The help screen shall be accessible by using the standard Microsoft Windows help system. These help screens shall contain context sensitive information that will allow the operator to enter correct data without consulting the manual.

FF. System Status:
1. Real time status: The operator shall be able to monitor via graphical screens, the status of the following in real time:
   a. Panels
   b. Doors
   c. Inputs
   d. Outputs
   e. Lockdown status
   f. Workstations on/off line
   g. Wireless locks

GG. Graphical Floor Maps:
1. Graphics File Format: The floor plans will be configured in a .JPG, .BMP, .PNG, .DWG & .ico formats to allow for the importation of existing drawings.
2. Icons: The system shall allow the operator to assign doors, inputs, relays, links and Access Control Panels to these floor plans to indicate the exact location of the event.
3. Operation: Upon activation of a selected input or door alarm, the system shall be able to automatically view the associated floor plan with the alarmed icon blinking on the monitor.

HH. Photo Import/Tracking:
1. The Photo Import & Tracking shall be a standard feature that is used in conjunction with the ACS software. The ACS does not require the operator to enter data more than once.
2. Events at the reader will display in real time and show a "split screen" of the stored cardholder image next to the "captured" image in case DVR interfaces are being used.
3. The system shall be capable of importing images of the cardholders and will store them in the database. These images will be able to be recalled and displayed by the operator.

4. The system operator may choose to disable the imaging function if it is not being used by the system.

II. First In/Last Out rule:
1. The Free Access schedule shall not energize until an authorized user with First In permissions shall enter an Access Control Door.
2. The Free Access schedule shall be able to be overridden when an authorized user with Last Out permissions presents a valid ID at an out reader.

JJ. Door Lockdown:
1. The system operator shall have the ability to lockdown a door/facility with a drop down, user defined window of a series of doors. This action shall override the Free Access Time schedule and will not return to a Free Access Time schedule until the operator manual removes the lockdown command from the drop down menu.

KK. Visitor Control:
1. The system shall allow the administrator to create temporary badge records for use by visitors.
2. The visitor function shall provide for an activation date, at which time the visitor badge will become enabled and an expiration date at which time the badge will become disabled.

LL. Badging 4K Video Badging:
1. The optional Badging 4K package for CA4K™ shall enable the users to easily capture cardholder images, add custom text and images, create custom card layouts and print ID cards or credentials with magnetic stripes, bar codes and smart chips.
2. Cardholder images will be able to either be captured remotely with a handheld digital camera and imported into the PC or directly captured via an internal frame grabber and video camera.
3. The following is a list of features that shall be supported:
    a. Drag-and-Drop WYSIWYG Badge Template Editor
    b. Desktop Automated Camera Capture
    c. Context Sensitive On-Line Help
    d. User Defined Badge Templates
    e. Printing:
        1) Shall support any Windows-compatible printer
        2) Will print both sides of a layout (duplex printing)
        3) Will support CMYK
        4) Landscape and portrait printing
    f. Image Capture:
        1) Direct camera drivers for Canon & Twain based webcams
        2) Advanced Face-finding feature will automatically locate a face within an image then centers, crops and stores it.
        3) Will support importing from file, AVI, TWAIN & WinTab
        4) Will point and click configuration of image capture devices
        5) Plug-in functionality according to plug-in driver capabilities
        6) Chroma key support
    g. Image Support:
        1) Will support most industry standard image file formats
        2) Will auto size static images to match size of object to physically Correct color and crop during image acquisition
        3) Special effects
        4) Red-eye removal
        5) Image enhancement
        6) Print images with watermarks

4. Additional Printing Support:
   a. Multiple alignment choices and duplex printing on cut-out sheets
   b. Point and click configuration of card printers and internal encoders
   c. Magnetic stripes can be encoded at print time
   d. Will easily copy, cut and paste elements between multiple design windows
   e. Duplex printing with user-definable printing modes
   f. Will select background color from standard and custom palettes
   g. Vertical text option
   h. Will draw lines, rectangles, round rectangles & ellipses
   i. Will create dynamic text objects including database fields and expressions
   j. Will create drop shadows
   k. Will apply pre-defined ghost effect to static and dynamic images
   l. User-definable fade or transparency levels with static and dynamic images
   m. Will remove background pixels from static and dynamic images (close cropping)
   n. Will add bar codes with user-definable properties and values
   o. Unlimited user-definable image types
   p. Will add static images with aspect ratio control
   q. Full True Type and ATM font support
   r. Will support all popular bar code types
   s. Will support Symbol® PDF417
5. E-mail, SMS and Pager Notification:
   a. The system shall allow the administrator to select alarm and/or badge activity event to be sent to a user via e-mail, SMS (text) or pager/cell-phone.
   b. The system shall allow the user a simple interface for email account setup.
6. Input and Activity Linking:
   a. The system shall allow for 'Activity Links' that provide the capability to control relays based on an event.
   b. Shall allow the CA4K™ to be a direct replacement for the Sensormatic AC500 system.
   c. Shall allow triggering of activity link in case any of the following events occur:
      1) AC Power Fail/Restore
      2) Input Abnormal/Normal
      3) Input Supervisory Open/Short/Fault
      4) Relay On/Off
      5) Link Activate/Deactivate
      6) Forced Door
      7) Door Closed
      8) Door Bypass
      9) Door Free Access Start/End
      10) Door Open Too Long
      11) Door Key Code Entry
      12) Manual Door Unlock/Lock
      13) Manual Door Enable/Disable
      14) Low/High Watermark
      15) Valid Badge
      16) Valid Badge Enabled
      17) Valid Badge Disabled
      18) Duress Access
      19) Denied Void Badge
      20) Denied Facility Match
      21) Denied Time Of Day
      22) Denied Issue Level

23) Denied Unauthorized
24) Denied PIN Violation
25) Denied APB IN/OUT
26) Denied Escort Match
27) Denied Reissue
28) Denied Vehicle Tag Match
29) Violate Exit Override
30) Violate Entry Override
31) Violate Time Of Day Override
32) Denied Interactivity Timeout
33) Activity Link ON/OFF

7. Category Counters: The Activity Link operation shall also include 16 category counters which allow the cardholder to trip a single or multiple activity links.
8. Watermarks: The watermark feature shall allow the system to 'count' the amount of cardholders/vehicles in a particular area. The user shall have the ability to set 'high' and 'low' marks for the system to increment and decrement the card/vehicle count. This can be used to disable a reader and disallow any further activity into the area until the watermark drops below the preset mark.
9. Local and Global Activity linking: The system shall support both local (within the same Access Control Panel) as well as global (spanning multiple Access Control Panels) Activity linking for maximum system flexibility.

MM. Alarm Event Limit:
1. This feature shall allow the user to limit the number of repeat alarm events sent from a panel within a given period of time.
   a. The user shall have the ability to add a time delay on an alarm to lessen the number of alarms that will be sent to the Pending Alerts grid for an input that remains 'Abnormal'.
   b. This time delay setting shall be configurable and shall be in minutes.
   c.

NN. Variable Door Open/Shunt Time:
1. This feature shall allow the user to unlock a door, either through Manual control or a card read, for a period as short as one second or up to one hour.
   a. The system shall bypass the door input for the same time as the unlock time.
   b. The system shall allow for time increments in seconds up to 59 and then in minutes only up to 60.
   c. The system shall allow for the same manual control over relays.

OO. Application Programming Interface:
1. The system shall provide for an Application Programming Interface for third party integration.
2. The API shall be constructed as a standard Windows Dynamic Link Library (DLL) and will provide various functionalities in the form of function calls.
3. The API shall consist of at least 50 functions calls.

PP. Right-to-Left Language Support:
1. The system shall support Languages requiring a display from right-to-left including, but not limited to, Arabic and Hebrew.

QQ. Access Control Panels: Continental Access Control Panels used by CA4K™ are modular in design. The access control panels (or panels for short) are also referred to as controllers. Two door, four door, eight door and sixteen door panel versions are available.
1. General Features:

a. PC Board: The Access Control Panel shall be a microprocessor controlled solid-state electronic device and will include a real time clock/calendar on board. The Access Control Panel shall be compliant with UL294, or an equal. A subset of the ACS database sufficient enough to support access and alarm functions for its designated readers and points will be able to be stored at the Access Control Panel. In the event of communication loss, the Access Control Panel will continue to function without any degradation in operation, and will provide storage for at least 1000 and utmost 210,000 transactions. These stored events will be uploaded to the CPU automatically upon the restoration of communications.

b. Modem Communication: The Access Control Panel shall be capable of operating over standard telephone lines using external modems. An Access Control Panel will automatically initiate a dial and will upload stored information in case the storage buffer is 80% full or in case a user defined alarm condition occurs. The CPU shall have the ability to automatically request information from the remote Access Control Panels based on a user defined time schedule.

c. Direct Communication: The Access Control Panel shall communicate via an RS232 or RS422 link directly to the ACS CPU. No additional interface equipment will be required. The Access Control Panel shall be capable of being configured in either repeat mode (serial) or in multi-drop mode. When in repeat mode, the distance between control panels shall be up to 4000 feet, communicating at 57,600 baud, without the use of modems or line drivers.

d. Electrical Noise Suppression: The controller shall have “Built-In” electrical noise suppression devices to protect the on-board microprocessor from relay-generated transients.

e. Electrical Surge Protection: The controller shall have “Built-In” electronic surge protection devices to protect controller circuitry to which external connections are made.

f. Battery Backup: The Access Control Panel shall include, as a standard, at least 4 hours of battery backup. The Access Control Panel also shall include internal battery backup to maintain controller database, program, time and date during a power loss.

g. Diagnostic LED’s: The Access Control Panel shall have an LED display to indicate power, processor heartbeat, and the transmission and receipt of programmed data.

h. Biometric Readers/Card Readers/Keypads: The Access Control Panel shall support entry/exit points that allow for a keypad to be used in conjunction with the reader, and the keypad accepts user-definable PIN codes. Systems requiring additional ports for the addition of a keypad are not acceptable. The Access Control Panel shall be able to support multiple card technologies (such as Proximity, Smart Readers, Smart Cards, Biometric-Fingerprint, Iris Scan, Hand Geometry, Face Recognition, Magnetic Stripe, Wiegand, etc.) concurrently without the need for additional software or hardware.

i. Inputs: Without the need for any additional hardware, each Access Control Panel will be able to monitor supervised alarm inputs. By means of software download, the Access Control Panel shall allow the user to decide whether the alarms must function as supervised or non-supervised inputs.

j. Outputs: Without the need for any additional hardware, each Access Control Panel will be able to control user-definable Form C relay outputs.

2. Hardware Options:

a. Alarm Expander Board: Additional inputs will be able to be made available by means of expansion boards mounted in the Access Control Panel enclosure. Each expansion board has a minimum of 16 supervised inputs. The Superterm, Turbo Superterm, Super Two, Accelaterm and Accelerator Access Control Panels shall be allowed to have a maximum of three expansion boards.

b. Relay Expander Board: Additional outputs will be able to be made available by means of expansion boards mounted either in the Access Control Panel enclosure, or in the

additional enclosures. Each expansion board shall have a minimum of 16 Form C relay outputs and 8 inputs. The Superterm, Turbo Superterm, Super Two, Accelaterm and Accelerator Access Control Panels shall be allowed to have a maximum of three expansion boards.

c. Memory Expansion: An additional memory board (20Mb) shall be available, allowing the Accelaterm and Accelerator expansion to (1,000,000) cards.

3. Enclosure: The Access Control Panel enclosure shall have a hinged cover with key lock. A control panel input point will monitor an enclosure tamper switch.

4. Software Features:

a. Facility codes: The Access Control Panel shall recognize up to ten different Facility Codes. These facility codes will be able to be defined and then assigned on a per cardholder basis or 100,000 system facility codes per panel with Facility Code/Badge Concatenation shall be selectable.

b. Card Formats: The Access Control Panel shall be capable of storing up to 10 custom card formats. The Access Control Panel will be able to read the format of most Magnetic Stripe, Bar Code, Proximity or Wiegand Effect encoded cards and will allow an operator to specify parity, start sentinels, stop sentinels, field separators, facility code bits, issue level bits, and card number bits.

c. Global Linking: The Access Control Panel will be able to store up to 64 unique linking programs. A link program will automatically trigger relay output(s) in response to alarm input(s). Inputs may be simple time schedule definitions or any one of up to five alarm inputs. In response, a maximum of five relays may be turned on/off, activated/deactivated, or relays may track the alarm input(s), for a length of time as defined by the user.

d. Card Number Length: The Access Control Panel shall be capable of reading card numbers up to 19 digits.

e. Time Schedules: The Access Control Panel shall have the capacity to store 255 time schedules, with each time schedule comprising of up to 10 time intervals. (The Access Control Panel thus will have the capacity to accommodate a total of 2550 time intervals). Each interval of time can consist of a range of days; seven days of the week, plus a Holiday Type Schedule. The Access Control Panel shall automatically manage time schedules based upon its internal clock.

f. Holidays: The Access Control Panel shall allow for the definition of 5 sets of 100 Holiday Schedules, or exceptions to normal scheduling. Holidays will be able to be defined according to day of year and time of day. All holidays will be automatically incorporated into Time Schedule definitions.

g. Holiday Types: The Access Control Panel shall allow for up to 5 Holiday types. Each Holiday type will consist of different Holiday schedules.

h. Access Modes: Each card reader/keypad shall have the ability to operate independently in up to five different modes: Card only, Common Code only, Card plus PIN, Free Access & Card or Card # through keypad. These modes of operation will be able to be programmed from the ACS host computer and can automatically change according to time schedule assignment.

i. Anti-pass back: The Access Control Panel shall support anti-pass back operation in which, the cardholders are required to follow a proper in/out sequence.

5. Controllers:

a. Continental Access manufactures different kinds of Access Control Panels in 1, 2, 4, 8 and 16 door configurations.

6. General Features:

a. PC Board: The aforementioned Access Control Panels shall be microprocessor controlled solid-state electronic devices and shall include a real time clock/calendar on board. They shall be compliant with UL294 or equal. A subset of the ACS database sufficient to support

access and alarm functions for their designated readers and points will be able to be stored at the Access Control Panel. In the event of communication loss, the Access Control Panels will continue to function without any degradation in operation, and will provide storage for a minimum of 20,000 cardholders and at least 1000 transactions.

b. Modem Communication: The aforementioned Access Control Panels shall be capable of operating over standard telephone lines using external modems. They shall automatically initiate a dial and upload stored transactions if the storage buffer is 80% full or if a user-defined alarm condition occurs. The CPU also shall have the ability to request information automatically from the remote Access Control Panels based on a user- defined time schedule.

c. Network Communication: The aforementioned Access Control Panels shall support the use of network communication devices to provide communication over LAN and WAN systems.

d. Direct Communication: The Access Control Panels shall communicate via an RS-232 or RS-422 link directly to the ACS CPU. No additional interface equipment will be required. The Access Control Panels shall be capable of being configured in either repeat mode (serial) or in multi-drop mode. When in repeat mode, the distance between the control panels may not exceed 4000 feet. The control panels shall need to be communicating at 57,600 baud, without the use of modems or line drivers.

e. Battery Backup: As a standard, the Access Control Panels shall include at least 4 hours of battery backup (7AH). They shall also include internal battery backup to maintain controller database, program, time and date during a power loss.

f. Diagnostic LED's: The Access Control Panels shall have an LED display to indicate power, and transmission/receipt of programmed data.

7. Hardware Features and Options:
   a. Card Readers: At least 16 supported
   b. Keypads: Allowed for PIN Code entry by users
   c. Inputs: At least 24 supervised alarm inputs can be monitored without the need for any additional hardware
   d. Outputs: Without the need for any additional hardware, at least 17 user definable form C relay outputs can be controlled
   e. Alarm Expander Board: Up to 3 expander boards allowed, each can have a minimum of 16 supervised inputs
   f. Relay Expander Board: Up to 3 expander boards allowed, each can have a minimum of 16 Form C inputs Up to 3 expander boards allowed, each can have a minimum of 16 Form C relay outputs and 8 inputs
   g. Memory Expansion Additional Memory module [256k,2Mb, 8Mb] shall be available, allowing expansion up to 1,000,000 cards

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: The contractor shall install all system components and appurtenances in accordance with Continental Access' instructions, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Provide mounting hardware as required.

B. Installation: All low voltage wiring outside the control console, cabinets, boxes, and similar enclosures, shall be plenum rated where required by code. Cable shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring.

C. Device Wiring and Communication Circuit Surge Protection: All inputs shall be protected against surges induced on device wiring. Outputs shall be protected against surges induced on control and device wiring installed outdoors, and as shown. All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors, except fiber optics, which serve as communications circuits from security console to field equipment, and between field equipment, shall have surge protection circuits installed at each end.

D. Review owner's desired settings and alerts and install as required.

E. Provide owner with no less than 4 hours of training at no additional cost. Record the training and provide audio video to the owner.

3.2 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

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

3.3 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for guard tours and key control.

11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.4 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

E. Install LAN cables using techniques, practices, and methods that are consistent with Category 5E rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.

F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

G. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.5 CABLE APPLICATION

A. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. (15 m).

D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. (1220 m).

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. (75 m).

3.6 GROUNDING

A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.7 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with TIA/EIA 606-A.

B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

3.8 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. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.10 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

3.12 COMMISSIONING

A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 019113 – General Commissioning Requirements.

B. Complete installation and startup checks and functional tests according to Section 019113 – General Commissioning Requirements and manufacturers written instructions.

C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the tart up procedure.

D. Verify that equipment is installed and commissioned as per requirements of Section 019113 and manufacturers written instruction/requirements.

END OF SECTION 281300

SECTION 281600 - INTRUSION DETECTION

PART 1. GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 019113-General Commissioning Requirements.

C. Technology Drawings.

D. “E” Drawings and Division 26 documents.

1.2 SUMMARY

A. Section Includes:

1. Intrusion detection with communication links to perform monitoring, alarm, and control functions.

B. Related Sections

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cabling between master control units and field-mounted devices and control units.
2. Section 281643 "Perimeter Security Systems" for outdoor intrusion detection devices, including lighting and communications associated with chain-link fence gates.
3. Section 282300 "Video Surveillance" for CCTV cameras that are used as devices for video motion detection.

1.3 DEFINITIONS

A. CCTV: Closed-circuit television.

B. PIR: Passive infrared.

C. RFI: Radio-frequency interference.

D. UPS: Uninterruptible power supply.

E. Control Unit: System component that monitors inputs and controls outputs through various circuits.

F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is

installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

I. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes.

J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.4 ACTION SUBMITTALS

A. CTHPB Documentation Submittals: Comply with Division 01 Section “Sustainable Design Requirements” and provide the following in addition to other action submittals:

1. Product Data for Credit 5d: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit 5d: For paints and coatings, including printed statement of VOC content.
3. Product Data for Credit d8: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
4. Product Certificates for Credit d10: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
5. Certificates for Credit d13: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
6. Laboratory Test Reports for Credit b4: For composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Product Data: Components for sensing, detecting, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers, networks and control interface devices and media to be used. Describe characteristics of network and other data communication lines.

    a. Indicate methods used to achieve systems integration.
    b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
    c. Describe characteristics of network and other data communication lines.
    d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

2. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
3. UPS: Sizing calculations.
4. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
5. Master Control-Unit Console Layout: Show required artwork and device identification.
6. Device Address List: Coordinate with final system programming.
7. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
8. Details of surge-protection devices and their installation.
9. Sensor detection patterns and adjustment ranges.

D. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

E. Samples for Initial Selection: For units with factory-applied color finishes.

F. Samples for Verification: For each type of exposed finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, intrusion detection systems integrator and testing agency.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

D. Other Information Submittals:

1. Test Plan and Schedule: Test plan defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.
2. Examination reports documenting inspections of substrates, areas, and conditions.
3. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

1.7 MATERIALS MAINTENANCE 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. Intrusion Detection Devices: Furnish quantity equal to five percent of the number of units of each type installed, but no fewer than one of each type.
2. Fuses: Three of each kind and size.
3. Tool Kit: Provide six sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
4. Security Fasteners: Furnish no fewer than 1 box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and Installer who has completed systems integration work for installations 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.

C. 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.

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. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.

F. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.

G. Comply with NFPA 70.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Altitude: Sea level to 1000 feet (305 m).
2. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
3. Interior, Controlled Environment: System components, except master control unit, installed in air-conditioned interior environments shall be rated for continuous operation in ambients of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Interior, Uncontrolled Environment: System components installed in non-air-conditioned interior environments shall be rated for continuous operation in ambients of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
5. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h).
6. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated, listed, and installed according to NFPA 70.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that are better than or equivalent to Honeywell.

2.2 DESCRIPTION OF SYSTEM

A. Description: Hard-wired, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

B. Motion Sensors shall not be required.

C. Glass sensors will not be required.

D. Alarm system shall be remotely monitored by a contracted vendor.

E. Security system will need to have direct communication with Owner's vendor.

F. Provide interior panic button at minimum at the front entrance receptionist and security office as shown on the drawings.

G. The Contractor will provide door contacts on all perimeter doors and the doors that separate Corridor V011 from Corridor I014 to secure the enter school perimeter and to secure the rest of the school from events that take place in the Cafeteria and Gymatorium areas. Refer to Section 087100 - Door Hardware and Door schedule for information on door provisions.

H. Keypads will be used to disarm the system.

I. The system will interface with the owner's Access Control System, so the Intrusion Detection system is disarmed upon successfully authentication at card reader entries of the Access Control System. Refer to Section 281300 Access Control.

J. The Contractor shall provide all cables, connectors, power supplies and terminations to provide a turn-key system.

K. The system should be configured for multiple partitions: providing the capability to disarm per partition. Partitions will be coordinated and determined with the owner.

L. Supervision: System components shall be continuously monitored for normal, alarm, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.

M. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.

N. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

O. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
5. Protected Zone Test: Initiate operational test of a specific protected zone.
6. System Test: Initiate system-wide operational test.
7. Print reports.

P. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.

Q. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

R. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.

S. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

T. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

U. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.3 SYSTEM COMPONENT REQUIREMENTS

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

B. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

C. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

D. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.

E. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

F. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

G. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.4 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, fiberglass.

D. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.5 SECURE AND ACCESS DEVICES

A. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

2.6 DOOR SWITCHES

A. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.

B. Flush-Mounted Switches: Unobtrusive and flush with surface of door.

C. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

D. Remote Test: Simulate movement of actuating magnet from master control unit.

2.7 MASTER CONTROL UNIT

A. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.

1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2. Include a real-time clock for time annotation of events on the event recorder and printer.
3. Addressable initiation devices that communicate device identity and status.
4. Control circuits for operation of mechanical equipment in response to an alarm.

B. Construction: Freestanding equipment rack, modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.

C. Comply with UL 609.

D. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: LCD, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
3. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
4. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
5. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:

    a. Acknowledge alarm.
    b. Silence alarm.
    c. System reset.
    d. LED test.

6. Timing Unit: Solid state, programmable, 365 days.

7. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
8. Alarm Indication: Audible signal sounds and a plain-language identification of the addressable detector originating the alarm appears on LED display at master control unit. Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.
9. Alarm activation sounds a siren.

E. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.

F. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.

G. UPS: Comply with Section 263353 "Static Uninterruptible Power Supply." UPS shall be sized to provide a minimum of six hours of master control-unit operation.

H. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch (25 mm) high. Identify, with permanent labels, individual components and modules within cabinets.

I. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.

J. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.8 AUDIBLE AND VISUAL ALARM DEVICES

A. The Contractor shall propose and provide the appropriate audible sirens and visual alarm devices for the system, include all related cabling, wiring, terminations and enclosures as per manufacturers requirements.

B. For exterior devices, as appropriate, enclosure: weather-resistant steel box with tamper switches on cover and on back of box.

2.9 SECURITY FASTENERS

A. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.

B. Drive System Types: Pinned Torx-Plus.

C. Socket Flat Countersunk Head Fasteners:

1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).

D. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F 1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
2. Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

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 intrusion detection.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

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

3.2 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

3.3 WIRING INSTALLATION

A. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 280513 "Conductors and Cables for Electronic Safety and Security."
4. Data and Television Signal Transmission Cables: Install according to Section 280513 "Conductors and Cables for Electronic Safety and Security."

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

F. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 260553 "Identification for Electrical Systems."

B. Install instructions frame in a location visible from master control unit.

3.5 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

E. Refer to “E” drawings.

3.6 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

E. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

F. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

3.9 COMMISSIONING

A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 019113 – General Commissioning Requirements.

B. Complete installation and startup checks and functional tests according to Section 019113 – General Commissioning Requirements and manufacturers written instructions.

C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the tart up procedure.

D. Verify that equipment is installed and commissioned as per requirements of Section 019113 and manufacturers written instruction/requirements.

END OF SECTION 281600

SECTION 282300 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 019113-General Commissioning Requirements.

C. Technology Drawings

D. Sections in Division 26 and Electrical Drawings

E. Sections in Division 27

F. Section 123900 Site Furnishings, See Bus Canopy Detail

1.2 SUMMARY

A. Section includes a video surveillance system consisting of cameras, server/digital video recorder, data transmission wiring, and a control station with its associated equipment.

B. All cameras shall be IP. POE network switches will connect and power the cameras unless otherwise noted will be provided by the owner. The POE network switches will be provided by others as part of the owner's FF&E portion of the project.

C. The video surveillance system should provision a minimum of 30 days retention storage and include HD Cameras only. All cameras should be fixed, no PTZ.

D. The video surveillance contractor, hereafter referred to as the contractor, shall furnish and install all materials, equipment (including indoor/outdoor camera mounting equipment, etc.) and software to provide a complete turn-key system. The project consists of but is not limited to internal and exterior cameras, appropriate mounting poles, mounts, mounting equipment, external power source such as POE injectors, hard-wired cameras, media converters and weather-proof cabinets.

E. The contractor shall mount all cameras including exterior cameras mounted on the exterior of the building. The exterior locations mounted to the facility shall be Cat6 locations, Cat 6 provided by Division 27.

F. The contractor shall mount exterior cameras at twelve (12) fiber locations mounted to the bus canopies and fiber locations at two (2) light pole locations as indicated on the drawings. Exterior camera locations not mounted to the building will be fiber optic OM3/OM4 locations homerun to the closest MDF/IDF data closets. Fiber optics runs will be provided by Division 27; however, the contractor will be responsible for furnishing, installing and testing a complete solution to provide media conversion and from fiber to Ethernet at the exterior camera locations and fiber to Ethernet media conversion at the MDF and IDF locations. The contractor shall also provide associates SFP's, fiber patch cables and POE injectors required to power the cameras. Alternatively, the contractor may provide a hard-wired

powered camera solution. The exterior fiber location cameras may be mounted to a weather-proof enclosure that houses the POE injector and media converter. The contractor shall provide the weather-proof enclosure and install the entire solution, which shall require electrical wiring to 110v electricity provided by Division 26 at the exterior fiber locations.

G. The contractor shall provide training to the owner's designated personnel and shall include no less than 8 hours at no additional cost. Furthermore, the contractor shall video record the training and provide a full copy to the owner.

H. The contractor shall ensure all cameras are installed and tested successfully; and adjust camera settings and views in order to ensure efficient coverage. The contractor shall coordinate and work with the owner's designated personnel as required in order to coordinate configurations and settings.

I. The contractor shall include one (1) 55" LCD or LED flat panel monitor including mounts and mount in main office as indicated on the drawings to receive video output from security station in security desktop. The contractor will provide the cabling required for HDMI (over Ethernet) from the security office to the main office. The contractor shall also include two (2) 27" monitors for the security office for local video output from a Windows based desktop running the security management software. The owner shall provide the desktop; however, the Contractor shall provide the monitors, including mounting and configuration of the security software on the desktops and configure as required. The contractor will work with the owner's designated personnel as required.

J. Provide, install and configure LPR. Adjust view for inbound and outbound traffic.

K. The contractor shall configure the system for decreased frames per second during no movement and increase frames per second when movement is detected.

L. All exterior cameras much be 11 megapixel or better and must have zoom in and zoom out via the video monitoring station.

M. The contractor shall adjust the cameras so the entire perimeter is under surveillance.

1.3 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. CCD: Charge-coupled device.

D. FTP: File transfer protocol.

E. IP: Internet protocol.

F. LAN: Local area network.

G. MPEG: Moving picture experts group.

H. NTSC: National Television System Committee.

I. PC: Personal computer.

J. PTZ: Pan-tilt-zoom.

K. RAID: Redundant array of independent disks.

L. TCP: Transmission control protocol - connects hosts on the Internet.

M. UPS: Uninterruptible power supply.

N. WAN: Wide area network.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. CTHPB Documentation Submittals: Comply with Division 01 Section “Sustainable Design Requirements” and provide the following in addition to other action submittals:

1. Product Data for Credit 5d: For adhesives and sealants, documentation including printed statement of VOC content.
2. Product Data for Credit 5d: For paints and coatings, including printed statement of VOC content.
3. Product Data for Credit d8: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
4. Product Certificates for Credit d10: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
5. Certificates for Credit d13: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
6. Laboratory Test Reports for Credit b4: For composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For video surveillance. 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. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
4. UPS: Sizing calculations.
5. Wiring Diagrams: For power, signal, and control wiring.

D. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For video surveillance, cameras, camera-supporting 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.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station 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. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.8 QUALITY ASSURANCE

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

B. Comply with NECA 1.

C. Comply with NFPA 70.

D. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

E. The contractor shall be a certified installer of the installed system, certified by the manufacturer.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
3. Interior, Uncontrolled Environment: System components installed in non-air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick. Use NEMA 250, Type 3R enclosures.
5. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion at no additional cost to the owner.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. The system design and solution described herein is based on Hikvision. Provide a system better than or equivalent to Hikvision. The approved and standardized manufacturer for Video Surveillance Systems is Hikvision.

B. Video-signal format shall comply with NTSC standard.

C. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

D. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

E. All cameras shall be HD, fixed. No PTZ.

F. The system should provide a minimum of 30 days storage.

G. The system should provide a fault tolerant NVR in the event that the primary goes down. Failover shall be configured and tested.

H. The system shall provide LPR (License Plate Recognition) capabilities and be configured and tested.

2.2 VIDEO SOFTWARE/MANGEMENT SYTEM

A. The system shall include a Video Surveillance Management Service, here after referred to as VSM, that is a windows based software installed on a server, designed to centrally manage Network Video Recorders (NVR), Digital Video Recorders (DVR), Central Video Recorders (CVR), and IP Cameras (IPC) via an IP based network (LAN, WAN or Internet).

1. VSM shall have the following maximum capacity for management of remote devices and event handling:
   a. Manage altogether up to 1024 encoding devices including those added from Remote Site Stations
   b. Import up to 3000 video channels (IPC or analogue/TVI) across X number devices
2. Manage up to 64 CVRs per VSM
3. Import up to 3000 alarm input/output respectively per VSM

B. Provide an application that manages the following Services of VSM.

a. Web Server

i. It is the content server and signaling gateway of the video surveillance system.

ii. It is mainly responsible for the storage of static page and reverse proxy of device configuration.

b. Video Surveillance Management Service

i. It is the core component of the video surveillance system, providing the authentication, permission granting, and management service.

ii. It authenticates the access of the client PC; manages the user, role, permission and monitor devices.

iii. It also provides the interface for third-party system integration.

c. Streaming Gateway

i. A component of VSM to forward and distribute the video and audio data.

ii. Up to 200 video channels @2Mbps input and 200 video channels @2Mbp/s output. Shall be used for concurrently live view or playback.

d. Streaming Service (Optional)

i. Installed on another PC or Server

ii. Configuration to allow central forwarding of live video streams thru VSM, to client PC, instead of directly from device to client PC

iii. Up to 300 video channels @2Mbps input and 300 video channels @2Mbps output. Must be used for concurrently live view or playback.

2.3 ACCESSIBILITY & MANAGEMENT CAPABILITIES

A. Up to 100 simultaneous Client Devices (CD) shall be able to connect using a thin or full client via a Windows based PC and 100 via an APP on a smart phone (Apple iOS or Android). There shall be no licensable client software or client software connection licenses required.

B. Must support Active Directory integration for user management of Client PCs and Mobile APPs (iOS and Android mobile operating systems).

C. Administration functions and operation functions shall be performed separately in the following parts.
1. Web Client: All administration of VSM shall be performed using web browser client via LAN, WAN or Internet. No client software required for administration of system.
2. Control Client: All security operator features will be accessed thru Control Client connected to VSM via LAN, WAN or Internet.
3. Mobile Client: Basic security operator features will be accessed thru Mobile Client connected to VSM via LAN, WAN or Internet.

D. Must include the ability to add remove sites by IP/Domain, IP Segment, Port Segment and/or batch import and add channel information.

E. Recording: Ability to configure camera recording schedule and Picture Storage.
1. Recording Configuration
   a. Batch adds new recording schedules.
   b. Delete/modify existing recording schedules.
   c. Filter recording schedules by customized rules
2. Picture Storage Configuration
   a. Turn on/off Picture Storage.
   b. Select picture storage location.
3. Recording Template Configuration
   a. Add recording template.
   b. Delete/edit recording template.

c. Filter existing recording schedules by customized rules.

2.4 Event & Alarm Monitoring: Shall have the ability toconfigure

A. To avoid flooding operator with alarms, shall have option of adding just an event from a device, that will be searchable via Control Client, but not annunciate as an alarm:
   1. Batch add following Video Content Analysis(VCA) events fromcameras
      a. Video Loss
      b. Video Tampering Detection
      c. Motion Detection
      d. PIR
      e. Scene Change Detection
      f. Defocus Detection
      g. Audio Exception Detection
      h. Sudden Increase in Sound Intensity Detection
      i. Face Detection
      j. Sudden Decrease in Sound Intensity Detection
      k. Face Capture
      l. Line Crossing
      m. Region Entrance
      n. Region Exiting
      o. Intrusion
      p. Loitering
      q. People Gathering
      r. Fast Moving
      s. Parking
      t. Object removal
      u. Fire source Detection
      v. Region Entrance Detection
      w. Region Exiting Detection
      x. Loitering Detection
      y. Blacklist Alarm
      z. Whitelist Alarm
   2. Batch add alarm input events
   3. Batch add Health Monitoring events from Device:
      a. Device Offline
      b. HDD Full
      c. R/W HDD Failure
      d. Video Standard Mismatch
      e. Camera/Recording Resolution Mismatch
      f. Array Exception
      g. Illegal Login
   4. Batch add Health Monitoring events from servers

B. Alarms: NVR and IPC events must also be able to be added directly as alarms by using alarm configuration tab
   1. Add ANPR events from the VSM as well as Remote Sites
      a. License Plate Matched Event
      b. License Plate Mismatched Event
   2. Same List of events listed above in section “a” are available to be programmed as alarms on VSM.
      a. When selecting triggering event to program as alarms, only events supported by device should appear in WebClient.

1) Individual alarm trigger shall be based on schedule
2) Alarm priority can be configured to one of three levels by default
   a) High
   b) Medium
   c) low
3) Alarm priority can be added up to 255 levels as required
4) Ability to set alarm type into different variation and states of response for alarm management and reporting
5) Shall have ability to set alarm recipients from user accounts set up in VSM
6) Ability to associate up to 16 cameras recording with alarm event
7) Ability to associate Map with alarm event
8) Ability to trigger pop-up with alarm
9) Ability to lock associates alarm event video footage, so it is not auto erased on camera schedule
10) Shall have ability to trigger alarm actions based on two settings
    a) Alarm occurs
    b) Alarms in not handled in X seconds
       Trigger Audible Warning
       Link alarm output
       Create Tag on video
       Send email - Shall have ability to create custom email templates

C. Vehicle: have ability to manage vehicle list for License Plate Recognition.
1. Import vehicle list
2. Export vehicle list
3. Sequence vehicle list
4. Delete vehicle list
5. Rename vehicle list name
6. Add basic vehicle information in one list, i.e. license plate number, owner and phone number.
7. Delete vehicle information in one list

D. Map: have ability to create graphical maps and place camera, alarm input and alarm output.
1. Add up to 6 levels and 1024 maps per VSM.
   a. On a map up to 128 camera/alarm input/alarm output hot spots/labels respectively can be added and up to 64 hot regions can be added
2. Create Map by importing pictures in JPEG, BMP or PNG format.
3. Ability to add “hot region” icon to be able to skip to different layer of map
4. Ability to add icon representing
   a. Camera
   b. Alarm Input
   c. Alarm Output
5. Ability to import pictures files to create custom map icons

E. Roles and Users
1. Shall have ability to create user profile groups defined as Roles.
2. Role shall have ability to restrict user profile access for administration functions defined as:
   a. Configuration and Control: with following categories of create definable access to
   b. Web Client for sub admin roles:
      1) Resource Management
      2) Recording settings
      3) Map settings
      4) Event and alarm settings

5) Role and User settings (Security)
6) System settings
7) Data Backup and restore settings

c. Control Client: for different levels of operator access
1) Client parameter settings
2) Log out
3) Alarm operations

d. Shall have the ability to set the Area display rule if “Area Hidden” function is enabled.

e. Resource: Each “Role” shall have ability to sub divide system and allow or deny access to the following features on a per camera basis:
1) Live view
2) Playback
3) Capture and Print Pictures
4) Video Search
5) Download
6) Activate Manual Recording
7) Two Way Audio
8) Tag Video
a) Add
b) Edit
c) Delete
d) View
9) Lock Video so it can’t be over written by schedule
a) Add
b) Edit
c) Delete
d) View
10) PTZ Control
11) Show Health Status
12) Alarm Output Control
13) Device (NVR, IPC)
a) Access device Parameters/settings
b) Broadcast
c) Log searches
d) Health Status
14) Show Server health status
15) Search log by user accounts

f. Shall be able to add up to 64 roles for user management per VSM

3. Users: Can be added 10,000 users by manually:
a. Create User name
b. Password is default on initial log in and then user must create password
c. Set expiration date of user profile
d. Select user status
e. PTZ Control Permission level
f. Assign Roles to the User

4. Active Directory Integration: Ability to import Windows Domain Users and assign them to roles
a. Domain user log in supported in Control Client and Mobile APPs (iOS and Android)

5. Security for Users
a. Lock IP Address
1) Failed Password attempts
a) Configurable: 1, 2,3,4, 5 number of attempts
b) Lock for: 10, 20, 30, 40, 50 or 60 minutes

2) Minimum password strength: Ability to select from thefollowing
   a) Weak
   b) Medium
   c) Strong
3) Enable Maximum Password Age
4) Auto Lock Control Client
5) Enable Area Hidden: Ability to assign the permission the specific roles to view only some certain areas if enabled.

F. Control Client
1. Control Client is a Windows based software for security operators to access NVRs, CVRs, and IPCs that associated client log-in credentials are authorized to view by the VSM. It provides multiple operating functionalities, including real-time live view, PTZ control, video playback and download/exporting, alarm management, VCA search, log query & health monitoring module.
2. Must provide a mobile client that includes multiple operating functionalities including real-time live view, video playback and alarm notification.

2.5 CAMERAS

A. Manufacturers: Subject to compliance with requirements, must be better than or equivalent to Hikvision.

B. Exterior cameras must be weather-proof and 11 Megapixel or better. Better than or equivalent to Hikvision DS-2CD4AC5F-IZH.

C. All cameras must be IP.

D. LPR cameras must be weather-proof

E. All cameras must have zoom-in and zoom-out features

F. All cameras must be vandal resistant

G. Indoor cameras must be 6 Megapixel or better. Indoor dome cameras better than or equivalent to Hikvision DS-2CD4165F-IZ.

H. The contractor may propose other model cameras as appropriate to provide appropriate coverage.

2.6 POWER SUPPLIES

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera and lens.

1. Enclosure: NEMA 250, Type 1.

2.7 CAMERA-SUPPORTING EQUIPMENT

A. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions.

B. Protective Housings for Fixed and Movable Cameras: Steel enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.

1. Tamper switch on access cover sounds an alarm signal when unit is opened or partially disassembled. Central-control unit shall identify tamper alarms and indicate location in alarm display. Tamper switches and central-control unit are specified in Section 281600 "Intrusion Detection."
2. Camera Viewing Window: Lexan window, aligned with camera lens.
3. Duplex Receptacle: Internally mounted.
4. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
5. Built-in, thermostat-activated heater and blower units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
6. Sun shield shall not interfere with normal airflow around the housing.
7. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
8. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
9. Enclosure Rating: NEMA 3R.

2.8 MONITORS

A. Manufacturers: Subject to compliance with requirements, better than or equivalent to NEC, Asus and or HP.

2.9 NETWORK VIDEO RECORDERS

A. Manufacturers: Subject to compliance with requirements, better than or equivalent to Hikvision.

B. Provide a failover solution and storage for 30 days plus room for 20% growth.

2.10 MEDIA CONVERTERS AND RELATED EQUIPMENT

A. Media converters, shall be better than or equivalent to Axis T8604. Provide sufficient number of media converters for “each end” of the fiber run.

B. SFP’s – provide SFP modules, better than or equivalent to accommodate OMC4/OM4 multimode fiber connections. Connections should be LC. Provide sufficient number of SFP’s to connect the exterior cameras to the owner’s Ethernet network. Better than or Equivalent to Axis. The contractor is responsible for making sure the SFP is compatible with the owner’s network equipment.
1. The owner’s standardized network switching equipment is Hewlett Packard Procurve switches.

C. Fiber Patch cables – LC to LC factory made

D. Cabinets & Racks – the contractor shall provide outdoor cabinets for the media converters and power for cameras. Better than or equivalent to Axis T98A15-VE. Provide sufficient number of cabinets for cameras; one cabinet per camera.
   1. The contractor shall include a rack solution for the media converters in the data closets. A data shelf may be accepted, better than or equivalent to Middle Atlantic.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

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

3.2 WIRING

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

B. Wiring Method: Install cables in raceways unless otherwise indicated.

   1. Except raceways are not required in accessible indoor ceiling spaces and attics.
   2. Except raceways are not required in hollow gypsum board partitions.
   3. Conceal raceways and wiring except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. 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-486B.

E. For LAN connection and fiber-optic and copper communication wiring, comply with Section 271300 "Communications Backbone Cabling" and Section 271500 "Communications Horizontal Cabling."

F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

D. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

F. Avoid ground loops by making ground connections only at the control station.

1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.

G. Identify system components, wiring, cabling, and terminals according to Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

    a. Prepare equipment list described in "Informational Submittals" Article.
    b. Verify operation of auto-iris lenses.
    c. Set and name all preset positions; consult Owner's personnel.
    d. Set sensitivity of motion detection.
    e. Connect and verify responses to alarms.
    f. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

C. Video surveillance system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.7 DEMONSTRATION

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

3.8 COMMISSIONING

A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 019113 – General Commissioning Requirements.

B. Complete installation and startup checks and functional tests according to Section 019113 – General Commissioning Requirements and manufacturers written instructions.

C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the tart up procedure.

D. Verify that equipment is installed and commissioned as per requirements of Section 019113 and manufacturers written instruction/requirements.

END OF SECTION 282300

SECTION 283100 - FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 DESCRIPTION:

A. This section of the specification includes the furnishing, installation, connection and testing of a microprocessor control, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Remote Control Panels, auxiliary control devices, transponders, annunciator, and wiring as shown on the drawings and specified herein.

B. The fire alarm system shall comply with requirements of 2002 NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

C. The fire alarm manufacturer shall be of the highest caliber and insist on the highest quality. The system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

D. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).

E. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing.

1.2 DEFINITIONS:

A. Initiation Device: A manual or automatic operated device that when operated results in the transmission of a fire alarm or supervisory indication at the control panel.
   1. Common alarm initiation devices include:
      a. Smoke detectors.
      b. Heat detectors.
      c. Multi-criteria detectors.
      d. Manual pull stations.
      e. Water flow devices.
      f. Fire suppression system switches.
   2. Common supervisory initiation devices include:
      a. Valve position (tamper) switches.
      b. Water levels witches.
      c. Hi/Low pressure switches.
      d. Fire suppression system trouble switches.
      e. Carbon Monoxide detectors.

1.3 RELATED SECTIONS

A. Related Sections:
   1. Division 01 Section – Cutting and patching
   2. Division 07 Section – Penetration Firestopping.
   3. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

4. Section 28 05 29 - Hangers and Supports for Electronic Safety and Security.
5. Section 28 05 53 - Identification for Electronic Safety and Security.
6. Section 27 05 26 - Grounding and Bonding for Communications Systems.

1.4 SCOPE:

A. New fire alarm equipment shall be installed in accordance to the project specifications and drawings.

B. Basic Performance:
1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
2. Initiation Device Circuits (IDC) shall be wired Class B (NFPA Style B) as part of an addressable device connected by the SLC Circuit.
3. Notification Appliance Circuits (NAC) shall be wired Class B (NFPA Style Y) as part of an addressable device connected by the SLC Circuit.
4. Digitized electronic signals shall employ check digits or multiple polling.
5. A single ground or open on the system signaling line circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
6. Alarm signals arriving at the main FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
7. NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zones whichever is greater.
8. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.
9. NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.

C. BASIC SYSTEM FUNCTIONAL OPERATION

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:
1. The system alarm LED on the FACP shall flash.
2. A local piezo electric signal in the control panel shall sound.
3. A backlit 80 character LCD display on the FACP shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
4. Printing on the FACP and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated, including fan shut downs via notification to the facility DDC system, and security system functions shall be initiated thru the security head end controls.
6. Remote receiving station shall be notified automatically.

1.5 SUBMITTALS

A. General:
1. Ten copies of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.

B. Shop Drawings:
1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show annunciator layout, configurations, and terminations.
4. Provide battery calculations as described in Part 2 of this specification under “Batteries”.

C. Manuals:
1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets
2. Maintenance and instruction manuals shall be submitted per Paragraph 3.10 in Section 019113.
3. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
4. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

D. Software Modifications:
1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

E. Certifications:
1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

1.6 GUARANTY:

A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

1.7 APPLICABLE STANDARDS AND SPECIFICATIONS:

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards.

A. National Fire Protection Association (NFPA) - USA:
No. 12 CO_2 Extinguishing Systems

No. 12A & 12B	Halon Extinguishing Systems
No. 15	Water Spray Systems
No. 16	Foam/Water Deluge and Spray Systems
No. 72-1993	National Fire Alarm Code
No. 101	Life Safety Code

B. Underwriters Laboratories Inc. (UL) - USA:

No. 268	Smoke Detectors for Fire Protective Signaling Systems
No. 864	Control Units for Fire Protective Signaling Systems
No. 268A	Smoke Detectors for Duct Applications
No. 521	Heat Detectors for Fire Protective
No. 464	Audible Signaling Appliances
No. 38	Manually Actuated Signaling Boxes
No. 346	Waterflow Indicators for Fire Protective Signaling Systems
No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
No. 1971	Visual Notification Appliances

C. Local and State Building Codes.

D. All requirements of the Authority Having Jurisdiction (AHJ).

E. Distributor of fire alarm to be an approved UUJS certified company.

1.8 APPROVALS:

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL	Underwriters Laboratories Inc.
FM	Factory Mutual

B. The fire alarm control panel shall meet UL Standard 864 (Control Units) and UL Standard 1076 (Proprietary Burglar Alarm Systems).

1.9 MAINTENANCE MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish three manual station break-glass rods.

C. Furnish six keys of each type.

D. Provide (2) manual fire alarm pullstations, complete with all labor, material, and programming, to be located in the field as directed by the Local Authority Having Jurisdiction.

E. Provide (4) fire alarm audio/visual appliances, complete with all labor, material, and programming, to be located in the field as directed by the Local Authority having Jurisdiction.

F. Provide (1) addressable duct mounted smoked detectors, including all labor, material, and programming, to be located in the field as directed by the Local Authority having Jurisdiction.

1.10 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Provide (2) manual fire alarm pullstation.

C. Provide (2) fire alarm audio/visual appliances of each type.

D. Provide (4) addressable ceiling type smoke detector.

PART 2 PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL:

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.

B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

D. All equipment proposed is based on Notifier. Products of equal quality and functionality as manufactured by Edwards/EST and Simplex will be considered.

2.2 CONDUIT AND WIRE:

A. Metal Clad (MC) Cable:
1. Type FPLP cable with galvanized interlocking steel with continuous red stripe.
2. NEC Article 760 rating for fire alarm control cables.
3. Install multiconductor cabling in accordance with NEC article 730.
4. Use permitted above accessible ceilings and concealed within walls to devices. Provide conduit and wire for final homeruns to control panels , transponders and power supplies.
5. Conductors shall comply with paragraph C.

B. Conduit:
1. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
2. Where exposed, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.

4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4 inch (19.1 mm) minimum.

C. Wire:
1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits and signaling line circuits, and 14 AWG (1.63 mm) for notification appliance circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
5. Wiring used for the SLC multiplex communication loop shall be twisted and shielded and support a minimum wiring distance of 10,000 feet. In certain applications, the system shall support up to SLC loops with up to 1,000 feet of untwisted, unshielded wire. The system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication loop.
6. All field wiring shall be completely supervised.
7. The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs). Systems which do not allow or have restrictions in, for example, the amount of t-taps, length of t-taps etc., are not acceptable.

D. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.

E. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

F. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

2.3 MAIN FIRE ALARM CONTROL PANEL:

A. The specification is based on a Notifier Model NFS2-3030 main control panel. The system shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, annunciators, and other system controlled devices.

B. Operator Control:
   1. Acknowledge Switch:
      a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
      b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.
   2. Alarm Silence Switch:
      a. Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
   3. Alarm Activate (Drill) Switch:
      a. The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
   4. System Reset Switch:
      a. Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.
   5. Lamp Test:
      a. The Lamp Test switch shall activate all system LEDs and light each segment of the liquid crystal display.

C. System Capacity and General Operation:
   1. The control panel shall provide, or be capable of expansion to 636 intelligent/addressable devices.
   2. The system shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of 3.0 amps @ 30 VDC. It shall also include four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable notification appliance circuits.
   3. The system shall support up to 8 additional output modules (signal, speaker, telephone, or relay), each with 8 circuits for an additional 64 circuits. These circuits shall be either Class A (NFPA Style D) or Class B (NFPA Style Y) per the project drawings.
   4. The fire alarm control panel shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
   5. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel. The system shall be fully programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.
   6. The system shall allow the programming of any input to activate any output or group of outputs. Systems which have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.

7. The FACP shall provide the following features:
   a. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
   b. Detector sensitivity test, meeting requirements of NFPA 72, Chapter 7.
   c. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
   d. Nine sensitivity levels for alarm, selected by detector. The system shall also include up to nine levels of pre-alarm, selected as a percentage of the alarm level, in steps from 90% down to 50%.
   e. System status reports to display or printer.
   f. Alarm verification, with verification counters.
   g. PAS pre-signal, meeting NFPA 72 3-8.3 requirements.
   h. Rapid manual station reporting (under 3 seconds).
   i. Non-alarm points for general (non-fire) control.
   j. Periodic detector test, conducted automatically by the software.
   k. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its pre-alarm level to just above normal peaks.
   l. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
   m. Walk test, with a check for two detectors set to same address.
   n. Control-by-time for non-fire operations, with holiday schedules.
   o. Day/night automatic adjustment of detector sensitivity.
   p. Device blink control for sleeping areas.
   q. UL-1076 security monitor points.
8. The FACP shall be capable of coding notification circuits in march time (120 PPM), temporal (NFPA 72 A-2-2.2.2), and California code.

D. Central Microprocessor
1. The microprocessor shall be a state-of-the-art, high speed, 16 bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, non-volatile memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
2. The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
3. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.
4. A special program check function shall be provided to detect common operator errors.
5. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
6. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download. This program shall also have a verification utility which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.

E. Display
1. The display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display shall include status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.
3. The display shall include an 80-character back-lit alphanumeric Liquid Crystal Display (LCD). It shall also provide 8 Light-Emitting-Diodes (LEDs, that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY SIGNAL, SYSTEM TROUBLE, DISABLED POINTS, and ALARM SILENCED.
4. The display keypad shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
5. The display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.

F. Signaling Line Circuits (SLC)
1. The system shall include two SLC circuits. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric or thermal) and 159 intelligent modules (monitor or control) for a system capacity of 636 devices. Each SLC loop shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
2. The Loop Control Module (LCM) shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, pre-alarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
3. The detector software shall meet NFPA 72, Chapter 7 requirements and be certified by UL as a calibrated sensitivity test instrument.
4. The detector software shall allow manual or automatic sensitivity adjustment.

G. Serial Interfaces
1. The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Electronic Data Processing (EDP) peripherals.
2. One EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers which are not UL-Listed are not considered acceptable substitutes.
3. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
4. The EIA-485 interface may be used for network connection to a proprietary receiving unit.

H. Notification Appliance Circuit (NAC) Module
1. The notification appliance circuit module shall provide four fully supervised Class A or B (NFPA Style Z or Y) notification circuits. An expansion circuit board shall allow expansion to eight circuits per module.
2. The notification circuit capacity shall be 3.0 amperes maximum per circuit and 6.0 amperes maximum per module.
3. The module shall not affect other module circuits in any way during a short circuit condition.

4. The module shall provide eight green ON/OFF LEDs and eight yellow TROUBLE LEDs.
5. The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.
6. Each notification circuit shall include a custom label inserted to identify each circuits location. Labels shall be created using a standard typewriter or word processor.
7. The notification circuit module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL listed for use with up to 12 AWG wire.
8. Each circuit shall be capable of, through system programming, deactivating upon depression of the signal silence switch.

I. Control Relay Module
1. The control relay module shall provide six Form-C auxiliary relay circuits rated at 5 amperes, 28 VDC. An expansion circuit board shall allow expansion to eight Form-C relays per module.
2. Each relay circuit shall be capable of being activated (change in state) by any initiating device or from any combination of initiating devices.
3. The expansion module shall provide 8 green ON/OFF LEDs and 8 yellow LEDs (indicates disabled status of the relay).
4. The module shall provide a momentary switch per relay circuit that may be used to manually turn the relay ON/OFF or to disable the relay.
5. Each relay circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or word processor.
6. The control relay module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal blocks shall be UL listed for use with up to 12 AWG wire.

J. Digital Voice Command Center
1. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.
2. Function: The Voice Command Center equipment shall perform the following functions:
   a. Operate as a supervised multi-channel emergency voice communication system.
   b. Operate as a two-way emergency telephone system control center.
   c. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
   d. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
   e. Provide all-call Emergency Paging activities through activation of a single control switch.
   f. As required, provide vectored paging control to specific audio zones via dedicated control switches.
   g. Provide a factory recorded “library” of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
   h. Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading

or downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.

i. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SCL controlled switching.

j. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.

k. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

3. The voice control (speaker circuit) module shall provide four fully supervised Class B (NFPA Style Y) or Class A (NFPA Style Z) speaker circuits. An expansion circuit board shall allow expansion for up to eight circuits per module.
4. Each speaker circuit shall be capable of switching up to 30 watts maximum per circuit or 60 watts per four circuit module.
5. If a short-circuit trouble occurs on one of the circuits, that circuit will not activate on either manual or automatic command.
6. The module shall provide green ON/OFF LEDs and yellow TROUBLE LEDs.
7. The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.
8. Each voice circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or word processor.
9. The voice control module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL Listed for use with up to 12 AWG wire.
10. Each speaker circuit module may be programmed to activate on activation of the All-Call switch and to deactivate upon pressing the signal silence switch.

K. Enclosures:

1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
2. The back box and door shall be constructed of .060 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be selected for either right or left hand hinging.

L. Power Supply:

1. The Addressable Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
2. The Addressable Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.
3. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-200 amp-hours within a 48-hour period.
4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.

5. The Addressable Main Power Supply shall be power-limited per UL864 requirements Fire Fighters' Telephones

M. Audio Amplifiers (Size amplifiers with a minimum spare capacity of 20% and provide a minimum of one backup amplifier.)
1. The audio amplifiers will provide audio power (@ 25 Volts RMS) for distribution to the speaker circuits.
2. Multiple audio amplifiers may be mounted in the fire alarm control panel using additional cabinets if necessary.
3. The audio amplifiers shall include an integral power supply, and shall provide the following controls and indicators:
   - Normal Audio Level LED
   - Incorrect Audio Level LED
   - Brownout LED
   - Battery Trouble LED
   - Amplifier Trouble LED
   - Audio Amplifier Gain Adjust
4. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
5. All terminal blocks for the connection of field wiring shall have a removable plug-in and be hardwired to allow for ease of field wire installation in a cabinet or at a remote location.
6. The amplifier shall include audio input and amplified output supervision, back-up input, and automatic switch-over to back up (if primary amplifier should fail).
7. Amplifiers shall be backed up in groups (one amplifier backs up several).

N. Prerecorded Voice - Audio Message Generator
1. The voice communication system shall be capable of transmitting a prerecorded voice message to all speakers in the building, or to any programmed group of speakers.
2. Actuation of any alarm initiating device shall cause a pre-recorded message to sound over the speakers. The message shall be repeated four times.
3. A built-in microphone shall be provided to allow paging through speaker circuits and shall have priority over the alarm message.
4. The message generator shall provide an interface to allow paging through telephone circuits.
5. The audio message generator shall have the following controls and indicators to allow for proper operator understanding and control.
   - Audio Level Normal LED
   - All Call LED
   - On-Line LED
   - Amplifier Trouble LED
   - Speaker Trouble LED
   - All Call Switch
   - Local Speaker Volume Control
6. The prerecorded message shall be stored on a non-volatile read only memory chip. The message shall be up to 24 seconds in length. An optional random access chip shall be available for a field programmable message. This message shall be programmed through the system's microphone or downloaded via a cassette recorder. Systems which utilize prerecorded memory storage other than on ROM type memory chips are not suitable substitutes.

O. Specific System Operations

1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
3. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
4. Point Read: The system shall be able to display or print the following point status diagnostic functions:
   - Device status
   - Device type
   - Custom device label
   - View analog detector values
   - Device zone assignments
   - All program parameters
5. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.
6. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 1000 events. 200 events shall be dedicated to alarm and the remaining events are general purpose. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety.
   The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
8. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.
9. Software Zones: The FACP shall provide 99 software zones and 10 additional special function zones.
10. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:

a. Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
b. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
c. Walk test shall be selectable on a per device/circuit basis. All devices and circuits which are not selected for walk test shall continue to provide fire protection and if an alarm is detected, will exit walk test and activate all programmed alarm functions.
d. All devices tested in walk test shall be recorded in the history buffer.

11. Waterflow Operation (Provide one FMM-1 for Each)
    a. An alarm from a waterflow detection device shall activate the appropriate alarm message on the 80 character display, turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.
12. Supervisory Operation (Provide one FMM-1 for Each)
    a. An alarm from a supervisory device shall cause the appropriate indication on the 80 character display, light a common supervisory LED, but will not cause the system to enter the trouble mode.
13. Signal Silence Operation
    a. The FACP shall have the ability to program each output circuit (notification, relay, speaker etc.) to deactivate upon depression of the signal silence switch.
14. Non-Alarm Input Operation
    a. Any addressable initiating device in the system may be used as a non-alarm input to monitor normally-open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

2.4 SYSTEM COMPONENTS:

A. Speakers (Speaker/Strobes are to meet requirements of both paragraphs A and B)
1. All speakers shall operate on 25 VRMS or with field selectable output taps from 0.5 to 2.0 Watts.
2. Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).
3. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
4. The back of each speaker shall be sealed to protect the speaker cone from damage and dust.

B. Strobe lights shall meet the requirements of the ADA, UL Standard 1971, NFPA 2002 and shall meet the following criteria:
1. The pulse duration shall be between minimum of one second and maximum of two seconds.
2. Strobe intensity shall meet the requirements of UL 1971, NFPA 2002 and ADA.
3. All visual units shall be synchronized to meet ADA requirements using sync modules.

C. Alphanumeric LCD Type Annunciator
1. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions in the system.
3. An audible indication of alarm shall be integral to the alphanumeric display.
4. The display shall be UL listed for fire alarm application.

5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6000 feet from the control panel.
6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset which shall be protected from unauthorized use by a key switch or password.
8. Provide annunciator key switch to enable or disable operation of annunciator membrane control switches.

D. All interfaces and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL standard 864.

E. Field Wiring Terminal Blocks
1. For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for 18 to 12 AWG wire. Terminal blocks which are permanently fixed are not acceptable.

F. Transponders
1. Transponders shall be listed under UL category UOJZ as an independent, local fire alarm control unit as well as being listed as a critical component in a multiplex fire alarm system. Transponders shall be located where shown on the plans.
The transponder shall serve as the interface between initiating fire devices, controlled signaling devices, and each FACP node. The supervised multiplex communication port shall be an integral part of the transponder.
2. Each transponder shall be powered from a local power supply, and shall provide all power necessary for its own operation, including standby power.
3. Transponders shall communicate with, and be controlled by, the host FACP via a 2-wire communications loop. The communications loop shall operate as an NFPA Style 4, Style 6 or Style 7 loop.
4. Transponders shall be used to house amplifiers, batteries and power supplies to allow true distributed processing and amplification.
5. Each transponder shall have the following indicators and operator controls:
Alarm Acknowledge/Reset Switch
Power LED
System Alarm LED
System Trouble LED
Local Piezoelectric Signal
Red Alarm Per Initiating Device Circuit
Green On/Off LED Per Notification Appliance Circuit or Relay
6. Each transponder shall be capable of expansion of up to 24 field circuits of the following types in any mix:
a. Initiating Device Circuits (IDC): IDCs may be added to the transponder in groups of 8 Style B (Class B), or 4 Style D (Class A) circuits. Each circuit shall be capable of monitoring up to 30 compatible 2-wire smoke detectors, and/or any number of contact type initiating devices.
b. Fire Fighter's Telephone Circuits: Firefighter's telephone circuits may be added to the transponder in groups of up to 8 circuits.

c. Fire alarm speaker circuits: Fire alarm speaker circuits may be added to the transponder in groups of up to 8 circuits. Each circuit shall be cable of supervising the field circuit, and of transmitting up to 30 watts of audio power.

d. Auxiliary Control Relay Outputs: Auxiliary relay outputs may be added to the transponder in groups of eight individually controlled single Form-C circuits, or four dual Form-C circuits. All Auxiliary circuits shall be rated 2 A. @ 30 VDC.

2.5 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

A. Addressable Devices - General

1. Addressable devices shall use simple to install and maintain decade (numbered 1 to 16) type address switches.
2. Addressable devices which use a binary address setting method, such as a Dip switch, are difficult to install and subject to installation error. This type of device is not an allowable substitute.
3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel signaling line circuits.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. Smoke detector sensitivity shall be set in the fire alarm control panel and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.
8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. Detectors shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.

12. A magnetic test switch shall be provided to test each detector for 100% obscuration, reported to the FACP.
13. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
14. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

B. Addressable Manual Pull Box
1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger.
4. Stations shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

C. Intelligent Photoelectric Smoke Detector
1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

D. Intelligent Thermal Detectors
1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit. Up to 159 intelligent heat detectors may connect to one SLC loop.

E. Intelligent Duct Smoke Detector
1. The in-duct smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
3. Provide with sampling tubes extending the entire width of the duct.
4. Provide with keyed remote test/reset switches.

F. Intelligent Carbon Monoxide (CO) Detector
1. Advanced multi-criteria fire/CO detector shall be an addressable detector, with a separate signal for carbon monoxide (CO) detection. CO detection shall be per UL 2075 standards (complying with alarm threshold standards and sensitivity patterns of UL

2034). The CO detection signal shall report as a supervisory alarm only and shall not activate notification appliance circuits.

2. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.
3. The advanced multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in order to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The detector shall be capable of selecting the appropriate sensitivity levels based on the environment type (office, manufacturing, kitchen, etc.) in which it is installed, and then have the ability to automatically change the setting as the environment changes.
4. The CO detector component shall be capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.
5. The detector shall indicate CO trouble conditions, including six months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self test failure, IR self test failure, and freeze warning.

G. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops.
2. The monitor module shall mount in a 4-inch square, 2-1/8 inch deep electrical box.
3. The IDC zone may be wired for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1-1/4 inch x 1/2 inch. This version need not include Style D or an LED.

H. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
4. Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.
5. The control module shall be suitable for pilot duty applications and rated for a minimum of .6 amps at 30 VDC.

I. Lexan Pull Station Guards

1. Provide Stopper II Lexan guards with integral buzzer for all manual pull stations. Provide with gaskets and spacers as required for the specific wall application in all instances.

2.6 BATTERIES:

A. The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure. Provide battery calculations with the submittals to verify requirements are met.

B. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

C. If necessary to meet standby requirements, external battery cabinet and charger systems may be used.

2.7 UDACT

A. Digital Alarm Communicator Transmitter (UDACT). The UDACT is an interface for communicating digital information between a fire alarm control panel and a UL-Listed central station.
   1. The UDACT shall be an integral component of the fire alarm control panel requiring no interconnecting wiring or supervisory circuitry.
   2. The UDACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to two different telephone numbers.
   3. The UDACT shall be completely field programmable locally from the control panel keypad or remotely over a phone line using upload/download PC software.
   4. The UDACT shall be capable of transmitting events in at least 15 different formats. This ensures compatibility with existing and future transmission formats.
   5. Communication shall include vital system status such as:
      a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
      b. Independent Addressable Device Status
      c. AC (Mains) Power Loss
      d. Low Battery and Earth Fault
      e. System Off Normal
      f. 12 and 24-Hour Test Signal
      g. Abnormal Test Signal (per UL requirements)
      h. EIA-485 Communications Failure
      i. Phone Line Failure
   6. The UDACT shall support independent zone/point reporting when used in the Contact ID format. In this format, the UDACT shall support the transmission of up to 50 addressable points with the system. This enables the central station to have exact details concerning the location of the fire for emergency response.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas, or on existing block constructed walls with no means to fish wiring.

D. Locate intelligent CO detectors as far away from CO source (fossil fuel burning appliance) as practical to minimize false alarms while maintaining manufacturer spacing criteria and NFPA required coverage.

E. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Field technicians shall be NICET Level 1 (minimum) certified.

F. The factory trained technician shall install initial data and artwork at each interactive firefighter's display.

G. The factory trained technician shall design the graphic layout based on area diagrams and floor plans.

3.2 TEST

A. The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
3. Verify activation of all waterflow switches.
4. Verify supervisory signal on CO detection activation.
5. Open initiating device circuits and verify that the trouble signal actuates.
6. Open and short signaling line circuits and verify that the trouble signal actuates.
7. Open and short notification appliance circuits and verify that trouble signal actuates.
8. Ground all circuits and verify response of trouble signals.
9. Check presence and audibility of tone at all alarm notification devices.
10. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.
11. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
12. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.3 FINAL INSPECTION

A. At the final inspection, a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

3.4 INSTRUCTION

A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation" to the owner.

END OF SECTION

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include complying with CTHPB standards. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling and an indoor quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental compliance goals

1.3 SUMMARY

A. This Section includes the following:
1. Protecting existing trees and vegetation to remain including installation of staging fencing and temporary safety barricade.
2. Removing trees and other vegetation.
3. Clearing and grubbing.
4. Topsoil and subsoil stripping and stockpiling.
5. Removing above- and below- grade site improvements and off site disposal.
6. Removal and/or on-site pulverizing of designated pavements.
7. Transplanting of designated plant material.
8. Disconnecting, capping or sealing, and removing site utilities or abandoning site utilities in place.
9. Temporary erosion and sedimentation control.

B. Related Sections include the following:

1. Division 01 Section "Execution Requirements".
2. Division 01 Section "Temporary Facilities and Controls".
3. Division 31 Section "Earth Moving".
4. Division 32 Section "Turf and Grasses".

1.4 DEFINITIONS

A. Revise below to define topsoil according to local practices if required. Topsoil defined below is the raw material that may need screening and amending before meeting landscaper's definition of topsoil.

B. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other non-soil materials.

C. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

D. Form 816: "Standard Specifications for Roads, Bridges, and Incidental Construction", State of Connecticut, Department of Transportation, Form 816", with latest edition and supplement.

E. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

F. Retain one of two "Topsoil" paragraphs below; revise to define "topsoil" according to local practices if required. Topsoil is raw material that typically needs screening and amending before meeting planting soil mix requirements. First paragraph assumes topsoil depth is known and shown or specified; second paragraph assumes that Contractor will identify and determine depth of existing topsoil. Coordinate with "Topsoil Stripping" Article.

G. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

H. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.

I. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

J. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

K. Salvage in first paragraph below may add cost to Project; verify with Owner.

L. Remove and Salvage: Detach items from existing construction and deliver them to Owner.

M. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

N. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.5 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1.6 MATERIALS OWNERSHIP

A. Except for materials indicated to be stockpiled or to remain Owner's property, cleared and demolished materials shall become Contractor's property and shall be removed from the Project site.

1.7 SUBMITTALS

A. Photographs or video sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
   1. Use sufficiently detailed photographs or video recordings.

B. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

C. Topsoil stripping and stockpiling program.

D. Record drawings according to Division 1, Section "Project Closeout."

E. Identify and accurately locate capped utilities and other subsurface structural, electrical, and mechanical conditions.

F. Product data for safety barricade and root inoculant.

1.8 QUALITY ASSURANCE

A. Preconstruction Conference: Conduct conference at Project site to comply with requirements in Division 01, Section "Project Coordination". Coordinate meeting with project sediment and erosion control requirements.

B. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

C. All work shall comply with all codes, rules, regulations, laws and ordinances for the Town of Rocky Hill , the State of Connecticut, and all other authorities having jurisdiction.

1.9 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

B. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

C. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

D. Improvements on Adjoining Property: Authority for performing indicated removal and alteration work on property adjoining Owner's property will be obtained by Owner before award of Contract.

E. Peripheral areas outside the Contract limit line shall not be disturbed or used for storing materials.

F. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

G. Notify utility locator service or Call Before You Dig for area where Project is located before site clearing.

H. Review and verify all limits or improvements to be removed prior to commencing demolition operations.

I. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

J. Tree- and Plant-Protection Zones: Protect according to requirements on the Plans and Details.

K. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

L. Inspection: Verify existing condition of all items scheduled for demolition or removal. The Owner assumes no responsibility for the actual condition of structures or utilities to be demolished. Do not proceed with any work that will result with unsafe conditions causing a continuing or permanent hazard. Ascertain that all work scheduled for demolition can be safely accomplished in a proper time period.

M. Benchmarks: Protect all survey monuments, benchmarks, and property boundary pins. Replace if destroyed by Contractor's operations. Relocate designated monuments where and as directed by the Town of Rocky Hill . Coordinate and schedule work with Owner.

N. Permits/Fees: Coordinate with appropriate utility companies and pay any disconnect fees and obtain permits as necessary.

O. Provide 48 hours notice prior to conducting any site demolition operation.

1.10 REFERENCES

A. State of Connecticut Department of Transportation "Standard Specifications for Roads, Bridges and Incidental Construction", Form 816, as amended and including current supplemental specifications.

B. "2002 Connecticut Guidelines for Soil Erosion and Sediment Control" by The Connecticut Council on Soil and Water Conservation in cooperation with the Connecticut Department of Environmental Protection.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31, Section "Earth Moving."

B. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

2.2 SOIL EROSION AND SEDIMENTATION CONTROL

A. This item shall consist of temporary erosion control measures as shown on the Plans, or as ordered by the Architect, during the life of the contract to control water pollution, soil erosion, and siltation through the use of common erosion control methods including hay bales and siltation fences and silt sacks, construction entrances / anti-tracking pads. The temporary erosion control measures contained herein and as shown on the contract drawings shall be installed and coordinated to assure economical,

effective, and continuous erosion control throughout the construction period. The Contractor shall install and maintain the devices during construction. The maintenance shall be performed a twice week or after storm events of 0.5 inches or greater. Contractor shall have a log of the erosion control inspections

B. Siltation Fence:

1. Synthetic filter fabric should be a pervious sheet of polypropylene, nylon, polyester, ethylene or similar filaments and shall be certified by the manufacturer or supplier as conforming to the requirements in Table 1 below.

TABLE 1 – GEOTEXTILE SILT FENCING MINIMUM REQUIREMENTS

Physical Property	Test Method	Minimum Requirement
Filtering Efficiency	ASTM 5141	75% (min)
Grab tensile strength (lbs.)	ASTM D4632	100 lbs
Elongation at failure	ASTM D4632	15%
Mullen burst strength	ASTM D3786	250 psi
Puncture strength	ASTM 4833	50 lbs
Apparent opening size	ASTM D4751	No less than 0.90mm and no greater than 0.60 mm
Flow rate	ASTM D4491	0.2 gal/ft2/min
Permittivity	ASTM D4491	0.05 sec. -1 (min.)
Ultraviolet radiation stability %	ASTM D4355	70% after 500 hours of exposure (min)

2. The geotextile shall be non-rotting, acid and alkali resistant and have sufficient strength and permeability for the purpose intended, including handling and backfill operations. Filaments in the geotextile shall be resistant to absorption. The filament network must be dimensionally stable and resistant to de-lamination. The geotextile shall be free of any chemical treatment or coating that will reduce its permeability. The geotextile shall also be free of any flaws or defects which will alter its physical properties. Torn or punctured geotextiles shall not be used. The geotextile shall be on the Connecticut Department of Transportation's "Qualified Product List".
3. The geotextile silt fence must be staked and the geotextile entrenched to a minimum depth of six inches below the existing surface. The supporting posts shall be at least 42 inches long made of either 1.5 inch square hardwood stakes or steel posts with projections for fastening the geotextile and possessing a minimum strength of 0.5 pound per linear foot. The support posts shall be driven to a depth of at least 12 inches into existing ground and never installed more than 10 feet apart
4. Siltation fence shall be stored in a manner that will protect it from the elements. If stored outdoors, it shall be elevated and protected with a waterproof cover. Both the geotextile and threads associated with the fence shall be resistant to chemical attack, mildew, and rot. Each roll of fabric shall be labeled or tagged to provide product identification as well as inventory and quality control purposes.

C. Hay Bales:

1. The hay bales shall be made of hay or straw with 40 pounds minimum weight and 120 pounds maximum weight held together by twine or wire.

2. The stakes for anchoring hay bales shall be a minimum of 36 inches long and made of either hardwood with dimensions of at least 1.5 inches square or steel posts with a minimum weight of 0.5 pounds per linear foot.
3. The hay bales shall be entrenched to a minimum depth of 4 inches below the existing surface. Place the hay bales in a single row in the trench, lengthwise, with ends of adjacent bales tightly abutting on another and the binding oriented around the sides rather than along the tops and bottoms of the bale in order to prevent premature rotting of the bindings.
4. Anchor each bale with at least 2 stakes, driving the first stake in each bale toward the previous laid bale to force the bales together. Stakes must be driven a minimum of 18 inches into the ground. Fill any gaps between the bales with hay or straw to prevent water from escaping between the bales.
5. Backfill the bales with the excavated trench material to a minimum depth of 4 inches on the uphill side of the bales. Tamp down by hand or machine and compact the soil. Cover the disturbed area immediately uphill from the hay bale barrier with loose hay or straw to increase the barriers efficiency.
6. Hay bales shall be stored in a manner that will protect them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.

D. Silt Sacks:
1. Silt sacks are to be installed in those locations as shown on the Plans to protect newly installed drainage structures and existing drainage structures.

E. Construction Entrance:
1. The construction entrance is a stone stabilized pad located at points of vehicular ingress and egress on a construction site. The location, dimensions and details of the construction entrance are shown on the plans and in accordance with these specifications.
2. The stone used for this work shall conform to the requirements of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 816, as amended and including current supplemental specifications section M.01.01, Size No. 3.
3. The fibers in the geotextile used shall consist of synthetic polymers composed of at least 85% by weight polypropylenes, polyesters, polyamides, polyethylene, polyolefin’s or polyvinyl-chlorides. The fibers shall be formed into a stable network of filaments or yarns retaining dimensional stability relative to each other. The geotextile used shall be specifically intended for “road stabilization” applications, shall be consistent with the manufacturer’s recommendations for the intended use and shall be on the Connecticut Department of Transportation’s “Qualified Product List”.
4. The area of the construction entrance shall be cleared of all vegetation, roots and other organic or unsuitable material. At poorly drained locations install subsurface drainage insuring the outlet to the drains are free flowing. If using geotextile in place of free draining material, unroll the geotextile in a direction parallel to the roadway entrance in a loose manner permitting it to conform to the surface irregularities when the stone is placed. Unless otherwise specified by the manufacturer, the minimum overlap of geotextile panels joined without sewing according to the manufacturer’s recommendations. The geotextile may be temporarily secured with pins recommended or provided by the manufacturer but they shall be removed prior to placement of the stone. Place the stone according to the locations, dimensions and depth as shown on the plans.
5. The construction entrance shall be maintained in a condition that will prevent tracking, flowing and washing of sediment onto paved surfaces. Provide periodic top dressing with additional

stone or additional length as conditions demand. Repair any measures used to trap sediment as needed. Immediately remove all sediment spilled, dropped, washed or tracked onto paved surfaces. Roads adjacent to a construction site shall be left clean at the end of each day.

6. When the construction entrance is no longer needed, or upon project completion, the anti-tracking pad shall be removed in its entirety and the area shall be restored as directed. The pad materials and sediments shall be removed to a location approved by the Construction Manager and Architect.

2.3 SAFETY BARRICADE

A. The Safety Barricade shall be a temporary, polypropylene construction fence, fully stabilized for UV resistance, with 2 inch by 4.5 inch apertures.
   1. Color: Orange, height 4’0”.
   2. Top tension rope – 3/8” braided nylon/polypropylene rope.
   3. POSTS: Heavy gauge channel steel posts 6’0” long.

2.4 STAGING FENCING

A. Staging Fencing: Chain Link Fence, minimum 6’0” height, 11 gauge with 1-1/2” OD posts at 10’-0” maximum on center spacing. Top tension wire required.

2.5 ROOT INOCULANT

A. Inoculant shall be rooting growth hormone containing mycorrhizae.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to Plans and Details.

C. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

D. Locate and clearly flag all limits of clearing, including trees and vegetation to remain or to be relocated. Place flagging every 25’ oc. Review with Landscape Architect, City Planning Staff, City Tree Warden, and Owner. Modify limits as required.

E. Protect existing site improvements to remain from damage during construction.

F. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

A. Erect and maintain a safety barricade around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete. Post spacing 6’0”. Securely attach fencing to posts, including providing a top tension line, woven through top of fabric.
   1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
   2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.

B. Do not excavate within drip line of trees, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
   1. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
   2. Coat cut faces of roots more than 1-1/2 inches in diameter with emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
   3. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.
   1. Employ a qualified arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
   2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.4 UTILITIES

A. Arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing.
   1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
   1. Arrange with utility companies to shut off indicated utilities.
   2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Construction Manager and Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Construction and Architect's written permission.

D. Excavate for and remove underground utilities indicated to be removed.

E. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots. Selectively clear trees and prune branches with in 20’ of clearing limit line or property line. Pruning to conform to Class III Standards.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Selectively prune and cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
   3. Completely remove stumps, roots, obstructions, and debris typically extending to a depth of 36 inches below any subgrade. In athletic field areas where proposed fills are greater than 12’ in height, trees may be smoothly flush cut and no topsoil stripping or grubbing is required.
   4. Use only hand methods for grubbing within drip line of remaining trees.
   5. Chip removed tree branches and dispose of off-site or use for temporary ground cover to prevent erosion.
   6. Along property lines, notify Construction Manager and Architect before beginning clearing operations. Coordinate clearing, grubbing and selective pruning with Construction Manager and Architect, to maintain as much existing vegetation as is practical.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding 8-inch loose depth, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Prepare areas of existing loam so as to provide clump free topsoil. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
   1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
   2. Strip surface soil of unsuitable topsoil, including trash, debris, weeds, roots, and other waste materials.
   3. Where trees are indicated to remain, hold stripping a sufficient distance away to prevent damage to the root system.
   4. No topsoil stripping is required where proposed fills are greater than 12’ in height.

C. Stockpile materials away from edge of excavations without intermixing with other soil materials. Grade and shape stockpiles to drain surface water, in locations approved by the Construction Manager and Owner and consistent with sediment and erosion control requirements.
   1. Limit height of topsoil stockpiles to 72 inches.
   2. Do not stockpile topsoil within drip line of remaining trees.
   3. Stockpile surplus topsoil and allow for respreading entire amount of approved-stripped topsoil or haul excess topsoil to locations designated by the Owner. All excess approved topsoil remains the property of the Owner.

3.7 SUBSOIL STRIPPING

A. After topsoil is fully stripped, strip existing subsoil in all proposed pavement areas, within building footprint, in areas of shallow cuts, and in areas of shallow (less than 6' height) fills.

B. Strip subsoil to whatever depths are encountered in a manner to prevent intermingling with topsoil and general fill.

3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove all slabs, paving, curbs, gutters, and all base/subbase material as indicated to full depths encountered, unless specifically noted otherwise.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically, perpendicular and parallel to direction of traffic.
   2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.
   3. It is the Contractor's option to pulverize or remove existing pavements from site.
   4. Specific pulverizing equipment must be approved. Thoroughly break up bituminous pavement to maximize aggregate size of 2". Pulverize all pavements to their full depth. Stockpile all pulverized material only in permitted areas. Submit mechanical/sieve analysis of pulverized/base material. Final pulverized product may be re-used on-site if capable of specified compaction and meeting the requirements of gradation for Form 816, Article M.05.01. If not accepted, remove from site at no additional cost to Owner.

C. Remove existing site improvements, including pavements fences of various types, and signage.

D. Remove and salvage or reinstall site signage as indicated on plans. Coordinate new location with Owner and Architect.

3.9 DISPOSAL

A. Disposal: Remove unsuitable soil material, cleared and grubbed material, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property. No burning or burying on site is permitted.

B. Accumulation of disposal/waste materials on-site is not permitted.

C. All pavement demolition material remains the property of the Contractor, except as specifically noted to be retained or permitted to be re-used on-site.

D. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work

3.10 MAINTENANCE OF EXISTING SITE AREAS

A. The Contractor shall maintain all areas within the project limits, for the duration of the contract. This maintenance will include the continuous mowing of undisturbed lawn areas within project limits, as well as the removal of any debris within fenced off areas.

3.11 TREE TRANSPLANTING

A. The Contractor shall notify the Architect a minimum of 48 hours in advance of transplant operations, so the Architect can select and tag the trees to be transplanted.

B. All transplanting work will be done under the supervision of a licensed arborist.

C. All trees to be transplanted will be root pruned, two weeks in advance of actual moving. Initial excavation may be by machine, but each root 1-1/2 inches in diameter or greater will be trim cut by hand prior to temporary backfilling. Mix root growth hormone into temporary backfill material, in accordance with manufacturer's recommendations.

D. Size of root ball must be appropriate to the size and age of the tree being moved, as recommended by the licensed arborist.

E. Transplanting shall utilize a tree spade of sufficient size to transport the tree and root ball.

F. Set transplanted ball in bottom of pre-excavated hole, on undisturbed soil. Carefully backfill, while protecting root ball.

G. Wrap, stake and guy tree, in accordance with Nursery Recommendations.

3.12 TRANSPLANT HOLDING

A. All plant material indicated for transplanting shall be balled and burlapped or containerized conforming to current AN&LA Standards, including root ball size.

B. All transplanted material shall be maintained by the site contractor during the period between digging and replanting.

C. Contractor should inspect all materials prior to replanting to establish the condition of plants to be transplanted. Notify Construction Manager or Architect of any plants not suitable for replanting prior to planting.

END OF SECTION 31 10 00

SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."

B. GREEN BUILDING REQUIREMENTS - The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include complying with CTHPB standards. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling and an indoor quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental compliance goals

1.2 SUMMARY

A. Section Includes:
1. Excavating and filling for rough grading the Site.
2. Preparing sub-grades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Sub-base course for concrete walks and pavements.
6. Sub-base course and base course for asphalt paving and walks.
7. Subsurface drainage backfill for walls and trenches.
8. Excavating and backfilling trenches for utilities, detention /retention basins, and pits for buried utility structures.

B. Related Sections:
1. Division 01 Section "Construction Progress Documentation" for recording pre-excavation and earth moving progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
3. Division 03, Section 03 30 00 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
4. Divisions 33, 22, 23, and 26 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
5. Division 31, Section 31 10 00 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
6. Division 31, Section 312319 "Dewatering" for lowering and disposing of ground water during construction.
7. Division 31, Section 31 50 00 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.

8. Division 32, Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
9. Division 33, Section 33 46 00 "Sub-drainage" for drainage of foundations, slabs-on-grade, walls, and landscaped areas.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the sub-base course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated sub-grade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above sub-grade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below sub-grade elevations or beyond indicated lines and dimensions as directed by Construction Manager and Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
   3. Unauthorized Excavation: Excavation below sub-grade elevations or beyond indicated lines and dimensions without direction by Construction Manager and Architect. Unauthorized excavation, as well as remedial work directed by Construction Manger and Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
   1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
   2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.

I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Sub-base Course: Aggregate layer placed between the sub-grade and base course for hot-mix asphalt pavement, or aggregate layer placed between the sub-grade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

L. Sub-grade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below sub-base, drainage fill, drainage course, or topsoil materials.

M. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

N. Unsatisfactory soil: Any soil not meeting Conn. DOT Form 817 or project requirements.

O. Polluted soil: Soil affected by a release of a substance at a concentration above the analytical detection limit for such substance. The regulations of Connecticut State agencies section 22a-133k-1 through 22a-133k-3 and as supplemented and amended.

P. Contaminated soil: Soil where contamination is found that exceeds the State of Connecticut DEP Remediation Standards.

1.4 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct pre-excavation conference at Project site.
   1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
      a. Personnel and equipment needed to make progress and avoid delays.
      b. Coordination of Work with utility locator service.
      c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
      d. Extent of trenching by hand or with air spade.
      e. Field quality control.

1.5 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Geotextiles.
   2. Controlled low-strength material, including design mixture.
   3. Geofoam.
   4. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:
   1. Geotextile: 12 by 12 inches.
   2. Warning Tape: 12 inches long; of each color.

C. Qualification Data: For qualified testing agency.

D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698 or ASTM D 1557.

E. No blasting allowed.

F. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

G. Provide certification that any imported fill material is not “polluted soil” in accordance with the regulations of Connecticut State agencies section 22a-133k-1 through 22a-133k-3 and as supplemented and amended.

H. Final As-built of all items location and elevations prepared by a CT Licensed Land Surveyor in paper, Mylar and AutoCad format.

1.6 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
1. Do not proceed with work on adjoining property until directed by Construction Manager and/or Architect.

C. Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before beginning earth moving operations.

D. Do not commence earth moving operations until temporary site fencing and erosion and sedimentation control measures, specified in Division 31 Section 31 10 00 "Site Clearing," are in place.

E. Do not commence earth moving operations until plant-protection measures for Tree Protection are in place.

F. The following practices are prohibited within protection zones:
1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.

6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM or Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter, and conforming to non-polluted soil in accordance with the CT DEEP RSR definitions, and determined by the special inspector as suitable.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145 or a combination of these groups.
1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
2. All soils conforming to polluted soil in accordance with the CT DEEP RSR definitions.

D. Granular fill. Shall comply with the Standard Specifications M.02.01 items 1 or 2

E. Sub-base Material: Shall comply with the Standard Specifications M.02.02 items 1 or 2.

F. Base Course: Shall comply with the Standard Specifications M.02.03 except no recycled products will be allowed.

G. Processed aggregate base. Shall comply with the Standard Specifications M.05.01.

H. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

I. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

J. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

K. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.

L. Sand: Shall comply with the Standard Specifications M.03.01.2.

M. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: As specified by subsurface drainage manufacturer or as identified of the CT DOT Qualified Product list. Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
2. Survivability: As follows:
    a. Grab Tensile Strength: 157 lbf ; ASTM D 4632.
    b. Sewn Seam Strength: 142 lbf ; ASTM D 4632.
    c. Tear Strength: 56 lbf ; ASTM D 4533.
    d. Puncture Strength: 56 lbf ; ASTM D 4833.
3. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
4. Permittivity: 0.5 per second, minimum; ASTM D 4491.
5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separation Geotextile: As identified of the CT DOT Qualified Product list. Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
2. Survivability: As follows:
    a. Grab Tensile Strength: 247 lbf ; ASTM D 4632.
    b. Sewn Seam Strength: 222 lbf ; ASTM D 4632.
    c. Tear Strength: 90 lbf ; ASTM D 4533.
    d. Puncture Strength: 90 lbf ; ASTM D 4833.
3. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
4. Permittivity: 0.02 per second, minimum; ASTM D 4491.
5. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:
1. Portland Cement: ASTM C 150, Type I or Type II, meeting State of Connecticut DOT standards for use as mix-water for cast-in-place concrete.
2. Fly Ash: ASTM C 618, Class C or F.
3. Normal-Weight Aggregate: ASTM C 33, 3/8-inch nominal maximum aggregate size.
4. Foaming Agent: ASTM C 869.
5. Water: ASTM C 94.
6. Air-Entraining Admixture: ASTM C 260

B. Produce low-density, controlled low-strength material with the following physical properties:
   1. As-Cast Unit Weight: 30 to 36 lb/cu. ft. at point of placement, when tested according to ASTM C 138.
   2. Compressive Strength: 80 psi , when tested according to ASTM C 495.

C. Produce conventional-weight, controlled low-strength material with 80-psi compressive strength when tested according to ASTM C 495.

2.4 GEOFOAM

A. Extruded-Polystyrene Board Insulation: ASTM C 578,
   1. Type IV, 1.55-lb/cu. ft. density, 25-psi compressive strength
   2. Type X, 1.30-lb/cu. ft. density, 15-psi compressive strength
   3. Type VI, 1.80-lb/cu. ft. density, 40-psi compressive strength
   4. Type VII, 2.20-lb/cu. ft. density, 60-psi compressive strength
   5. Type V, 3.00-lb/cu. ft. density, 100-psi compressive strength.

B. Molded-Polystyrene Board Insulation: ASTM C 578,
   1. Type I, 0.90-lb/cu. ft. density, 10-psi compressive strength
   2. Type VIII, 1.15-lb/cu. ft. density, 13-psi compressive strength
   3. Type II, 1.35-lb/cu. ft. density, 15-psi compressive strength.
   4. Manufacture molded polystyrene with an inorganic mineral registered with the EPA and suitable for application as a termite deterrent.

C. Rigid Cellular Polystyrene Geofoam: ASTM D 6817,
   1. Type EPS 19, 1.15-lb/cu. ft. density, 5.8-psi compressive strength at 1 percent deformation; 16-psi compressive strength at 10 percent deformation
   2. Type EPS 39, 2.40-lb/cu. ft. density, 15-psi compressive strength at 1 percent deformation; 40-psi compressive strength at 10 percent deformation.

D. Connectors: Geofoam manufacturer's multibarbed, galvanized-steel sheet connectors or Deformed steel reinforcing bars, 3/4 inch in diameter.

2.5 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the 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 as follows:
   1. Red: Electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Preparation of sub-grade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, during earthwork operations.

D. Provide protective insulating materials to protect sub-grades and foundation soils against freezing temperatures or frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared sub-grades, and from flooding Project site and surrounding area.

B. Protect sub-grades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to sub-grade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
   2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
      a. 24 inches outside of concrete forms other than at footings.
      b. 12 inches outside of concrete forms at footings.
      c. 6 inches outside of minimum required dimensions of concrete cast against grade.
      d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      e. 6 inches beneath bottom of concrete slabs on grade.
      f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

B. Classified Excavation: Excavate to sub-grade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Special Inspector. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
   a. Intermittent drilling; blasting is not permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
   b. Rock excavation includes removal and disposal of rock. Remove rock to lines and sub-grade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
      1) 24 inches outside of concrete forms other than at footings.
      2) 12 inches outside of concrete forms at footings.
      3) 6 inches outside of minimum required dimensions of concrete cast against grade.
      4) Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      5) 6 inches beneath bottom of concrete slabs on grade.
      6) 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

C. Polluted soil: Excavate to design limits and stockpile separately from all other soil. Dispose off site in accordance with State of Connecticut DEP regulations with manifest, the same protocol as contaminated and hazardous soil. The contractor is responsible for engaging a special inspector qualified and trained to sample the soils identified as polluted and any other soils where concerns become apparent. The special inspector must submit to a licensed laboratory under a chain of custody for the characterization for the disposal criteria of the selected facility.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.

3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

4. Excavate by hand to indicated lines, cross sections, elevations, and sub-grades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

5. Cut and protect roots according to requirements for tree protection and trimming .

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and sub-grades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, and where indicated on the drawings, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
   1. Clearance: 12 inches each side of pipe or conduit, or as indicated on Drawings.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe. Shape sub-grade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench sub-grade.
   1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed sub-grade.
   2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
   3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed sub-grade.
   4. Excavate trenches 12 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree and Plant Protection Zones:
   1. Hand-excavate to indicated lines, cross sections, elevations, and sub-grades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.8 SUB-GRADE INSPECTION

A. Notify Construction Manager and Architect when excavations have reached required sub-grade.

B. If Construction Manager and/or Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll sub-grade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated sub-grades.
   1. Completely proof-roll sub-grade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Construction Manager and Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct sub-grades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Construction Manager and/or Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Construction Manager or Architect.

B. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Construction Manager and Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
2. Stockpile unsatisfactory soils separately from all others.
3. Stockpile polluted soil separately from all others. Cover with 2 layers of 6 mil polyethylene with anchoring to prevent blow off.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
1. Construction below finish grade including, where applicable, sub-drainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on sub-grades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on sub-grades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete." and Section 033053 "Miscellaneous Cast-in-Place Concrete."

D. Trenches under Roadways: Backfill as specified on Drawings.

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill as specified on the Drawings, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Controlled Low-Strength Material (if required): Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

H. Place and compact final backfill of satisfactory soil to final sub-grade elevation.

I. Controlled Low-Strength Material (if required): Place final backfill of controlled low-strength material to final sub-grade elevation.

J. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below sub-grade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.
   6. Under tanks and subsurface structures use engineered fill.

C. Place soil fill on sub-grades free of mud, frost, snow, or ice.

3.14 GEOFOAM FILL

A. Place a leveling course of sand, 2 inches thick, over subgrade. Finish leveling course to a tolerance of 1/2 inch when tested with a 10-foot straightedge.
   1. Place leveling course on subgrades free of mud, frost, snow, or ice.

B. Install geofoam blocks in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. Offset joints of blocks in successive layers.

C. Install geofoam connectors at each layer of geofoam to resist horizontal displacement according to geofoam manufacturer's written instructions.

D. Cover geofoam with subdrainage or separation geotextile before placing overlying soil materials.

3.15 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate sub-grade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.16 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 or ASTM D 1557:
   1. Under structures, building slabs, steps, and pavements, scarify and re-compact top 12 inches of existing sub-grade and each layer of backfill or fill soil material at 95 percent.
   2. Under walkways, scarify and re-compact top 6 inches below sub-grade and compact each layer of backfill or fill soil material at 92 percent.
   3. Under turf or unpaved areas, scarify and re-compact top 6 inches below sub-grade and compact each layer of backfill or fill soil material at 85 percent.
   4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.17 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish sub-grades to required elevations within the following tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch .
   2. Walks: Plus or minus 1 inch .
   3. Pavements: Plus or minus 1/2 inch .

C. Grading inside Building Lines: Finish sub-grade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.18 SUBSURFACE DRAINAGE

A. Sub-drainage Pipe: Specified in Division 33, Section33 46 00 "Subdrainage."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of sub-drainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support sub-drainage pipe. Encase sub-drainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final sub-grade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.
2. Place and compact impervious fill over drainage backfill in 6-inch thick compacted layers to final sub-grade.

3.19 SUB-BASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place sub-base course and base course on sub-grades free of mud, frost, snow, or ice.

B. On prepared sub-grade, place sub-base course and base course under pavements and walks as follows:
1. Install separation geotextile (if required) on prepared sub-grade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over sub-base course under hot-mix asphalt pavement.
3. Shape sub-base course and base course to required crown elevations and cross-slope grades.
4. Place sub-base course and base course 6 inches or less in compacted thickness in a single layer.
5. Place sub-base course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
6. Compact sub-base course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698 or ASTM D 1557.

3.20 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on sub-grades free of mud, frost, snow, or ice.

B. On prepared sub-grade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
1. Install sub-drainage geotextile (if required) on prepared sub-grade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.21 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   2. Determine that fill material classification and maximum lift thickness comply with requirements.
   3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
   4. Sample and submit to a licensed laboratory to submit to the disposal facility for their disposal criteria for polluted soil.
   5. Sample and submit to a licensed laboratory any soils that exhibit, or are suspected of exhibiting characteristics of contaminated soil.

B. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing and inspection.

C. Allow testing agency to inspect and test sub-grades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work complies with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Construction Manager and Architect.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   1. Paved and Building Slab Areas: At sub-grade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three (3) tests.
   2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two (2) tests.
   3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than two (2) tests.

F. When testing agency reports that sub-grades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.

G. Where excavated material meets the definition of polluted soil, stockpile separately, cover with 6 mil polyethylene

H. The contractor is responsible for identifying polluted, contaminated soil, and the cost for laboratory testing, removal, replacement, and disposal.

3.22 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Construction Manager and Architect; reshape and re-compact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, polluted soil, trash, and debris, and legally dispose of it off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Special Inspector, or dispose off site.
   1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

C. Dispose of all “Polluted soil” and “Contaminated Soil” in full conformance with State of Connecticut DEEP regulations, including all laboratory testing for classification, loading, hauling, and disposal.

END OF SECTION 31 20 00

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section “Summary.”

B. GREEN BUILDING REQUIREMENTS - The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include complying with CTHPB standards. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling and an indoor quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental compliance goals

1.2 SUMMARY

A. This Section includes construction dewatering.

B. Related Sections include the following:
1. Division 1 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
2. Division 31, Section 31 50 00 "Excavation Support and Protection."
3. Division 31, Section 31 20 00 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.
4. Division 33, Section 33 46 00 "Subdrainage" for curtain drains and underdrains.

1.3 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable sub-grades.
1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to sub-grades and permanent structures is prevented.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
4. Remove dewatering system if no longer needed.

1.4 ACTION SUBMITTALS

A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.
   1. Include plans, elevations, sections, and details.
   2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
   3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
   4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, land surveyor, and professional engineer.

B. Field quality-control reports.

C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

D. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.

B. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

C. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Construction Manager and/or Architect and then only after arranging to provide temporary utility services according to requirements indicated.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner, Architect, and Site Engineer of Record will not be responsible for interpretations or conclusions drawn from this data.
   1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
   2. The geotechnical report is included elsewhere in the Project Manual.

C. Survey adjacent structures and improvements, employing a qualified land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
   1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Construction Manager and Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
   1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
   2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
   3. Prevent surface water from entering excavations by grading, dikes, or other means.
   4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
   5. Remove dewatering system when no longer required for construction.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
   1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared sub-grades, and from flooding site and surrounding area.
   2. Protect sub-grades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 311000 "Site Clearing," during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
   1. Space well points or wells at intervals required to provide sufficient dewatering.
   2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

E. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

F. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry sub-grades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
   1. Do not permit open-sump pumping that leads to loss of fines, soil piping, sub-grade softening, and slope instability.

G. Reduce hydrostatic head in water-bearing strata below sub-grade elevations of foundations, drains, sewers, and other excavations.
   1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.

H. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

I. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
   1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

J. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 OBSERVATION WELLS

A. Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.

B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.

C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
   1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

3.4 FIELD QUALITY CONTROL

A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.
   1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
   2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
   3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

B. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Construction Manager and Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.

D. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations.

B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 31 23 19

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."

B. GREEN BUILDING REQUIREMENTS - The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include complying with CTHPB standards. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling and an indoor quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental compliance goals

1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Sections:
1. Division 31, Section 31 20 00 "Earth Moving" for excavating and backfilling and for controlling surface-water runoff and ponding.
2. Section 312319 "Dewatering" for dewatering excavations.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.
1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations.
5. Review proposed equipment.
6. Review monitoring of excavation support and protection system.
7. Review coordination with waterproofing.
8. Review abandonment or removal of excavation support and protection system

1.4 SUBMITTALS

A. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.
1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

B. Product Data: For each type of product.
   1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

C. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.
   1. Include plans, elevations, sections, and details.
   2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
   3. Indicate type and location of waterproofing.
   4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

D. Qualification Data: For Installer and professional engineer.

E. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Photographs: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.

G. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of utility.
   2. Do not proceed with interruption of utility without Construction Manager’s and Owner's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.
   1. Make additional test borings and conduct other exploratory operations if necessary for excavation support and protection according to the performance requirements.
   2. The geotechnical report is included in the Project Manual.

C. Survey Work: Engage a qualified land surveyor to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
   1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Construction Manager and Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
   1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
   4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.2 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
   1. Corners: Site-fabricated mechanical interlock or Roll-formed corner shape with continuous interlock.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application 4 inches.

E. Shotcrete: Comply with Division 03, for concrete materials and mixes, reinforcement, and application and CT DOT Form 817, Section 6.11, Article M.11.04 and Article M.06.01.

F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

G. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

H. Tiebacks: Steel bars, ASTM A 722/A 722M.

I. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
   1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally to secure soldier piles.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet-piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
   1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
   2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
   1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Construction Manger and/or Architect.
   2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
   3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Construction Manager and/or Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.7 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
   1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
   2. Fill voids immediately with approved backfill compacted to density specified in Division 31, Section 31 20 00 "Earth Moving."
   3. Repair or replace, as approved by Construction Manager and /or Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

3.8 AS BUILT RECORD DRAWING

A. Provide a record drawing of all constructed items prepared by a Licensed Land Surveyor licensed in Connecticut. Provide a statement that the as built record conforms with the design, or as acceptable by the design engineer.

END OF SECTION 31 50 00

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section “Summary.”

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include complying with CTHPB standards. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling and an indoor quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental compliance goals

1.3 SUMMARY

A. This Section includes the following:
1. Cold milling of existing asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt overlay.
5. Asphalt curbs.
6. Asphalt traffic-calming devices.
7. Asphalt surface treatments
8. Pavement-marking paint.

B. Related Sections include the following:
1. Division 2, Section 02 41 19 "Selective Demolition" for demolition and removal of existing asphalt pavement.
2. Division 31, Section 31 20 00 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
3. Division 32, Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

1.4 REFERENCES

A. State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current editions and supplemental.

B. AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 1986 Edition, as amended.

1.5 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. DOT: Department of Transportation

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Include technical data and tested physical and performance properties.
   2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
   3. Job-Mix Designs: For each job mix proposed for the Work.
   4. Pavement marking paint and seal materials.

B. Qualification Data: For qualified manufacturer and testing agency.

C. Material Certificates: For each paving material, from manufacturer.

D. Material Test Reports: For each paving material, by a qualified agency

E. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the State of Connecticut DOT in which Project is located.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817 for asphalt paving work.

D. Pre-installation Conference: Conduct conference at the Project Site.
   1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
   2. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
   3. Review condition of sub-grade and preparatory work.
   4. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
   5. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if sub-grade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
   1. Prime Coat: Minimum surface temperature of 60 deg F.
   2. Tack Coat: Minimum surface temperature of 60 deg F.
   3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
   4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
   5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of as noted below in this specification for different pavement makings and applications.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Processed aggregate base shall conform to the requirements of Section 3.04 and M.05 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current supplemental.

2.2 ASPHALT MATERIALS

A. Bituminous Concrete shall conform to the requirements of Section 4.06 and M.04 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current supplemental.

2.3 AUXILIARY MATERIALS

A. Gravel sub-base shall conform to the requirements of Section 2.12 and M.02 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current supplemental.

B. Tack coat shall consist of either emulsified asphalt, Grade MS-1 conforming to Section M.04.01, or cationic emulsified asphalt, Grade CSS-1 or CSS-1H conforming to Section M.04.01 of the State of

Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current supplemental.

2.4 PAINTED PAVEMENT MARKINGS

A. Painted pavement markings, as noted on the plans, shall conform to the requirements of Section 12.10 and M.07 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current supplemental.

B. Epoxy resin pavement markings, symbols, and legends
   1. This item shall consist of furnishing and installing retroreflective white and yellow epoxy resin pavement markings of the width and color specified and epoxy resin pavement markings, symbols and legends at the locations indicated on the plans and in conformity with the plans, these specifications and as directed by the Construction Manager and /or Architect.
   2. Epoxy resin pavement markings includes epoxy resin installed with a truck-mounted machine such as center lines, lane lines, and shoulder lines.
   3. Epoxy resin pavement markings, symbols and legends include: parking stalls, legends, and markings within areas such as paved islands, gore areas and paved medians.
   4. Materials for this work shall conform to the requirements of Article M.07.22.
   5. Equipment furnished shall include an applicator truck of adequate size and power, together with remote application equipment designed to apply an epoxy resin material in a continuous pattern and portable glass bead applicators, one for each size bead, designed to provide uniform and complete coverage of the epoxy binder by a controlled free-fall method. Pressurized glass bead application shall not be used. Before epoxy color is changed, equipment shall be cleaned out sufficiently to ensure that the color of material applied will be correct.
   6. When working on a road it is contractor’s responsibility for insuring vehicle and pedestrian traffic and workers safety. Its cost shall be included in the bid price for this item.
   7. For markings applied on pavements over one year old, equipment furnished shall also include a power washing machine capable of cleaning the pavement with a pressure of 2,400 to 2,800 psi with water heated to 180° F - 195° F. No chemicals shall be added to the water used in the process. The power washer shall be equipped with a turbo blast tip with an oscillating head and shall be capable of supplying a minimum of 5 gallons/minute gun.
   8. All guns on the spray carriages shall be in full view of the operator(s) during operation.
   9. Each vehicle furnished shall include at least one experienced operator, who shall be fully knowledgeable about all equipment operations and application techniques.
   10. The Contractor shall also furnish one technical expert, who shall be fully knowledgeable about all equipment operations and application techniques, to oversee the project operation.
   11. Pavement markings shall be applied in accordance with the details shown on the plans and the control points established by the Contractor and approved by the Construction Manager and Architect.
   12. The road surface shall be cleaned at the direction of the Construction Manager and Architect just prior to application. Pavement cleaning shall consist of power washing using clean water heated to 180° F - 195° F at a pressure of 2,240 - 2,800 psi. The areas to be power washed shall include all areas where epoxy marking symbols and legends are to be applied and at least 1 inch beyond the area to be marked. The surface shall be cleaned to the satisfaction of the Construction Manager and/or Architect. For other pavement areas, cleaning shall consist of brushing with rotary broom (non-metallic), and any additional work as recommended by the material manufacturer and acceptable to the Construction Manager and/or Architect. New Portland cement concrete surfaces shall be cleaned by abrasive blasting to remove any surface treatments and/or laitance. New bituminous concrete surfaces are not to be power washed.

13. All surfaces that are power washed shall be allowed to dry sufficiently prior to the application of the epoxy markings. The areas to be marked shall be broom cleaned immediately prior to the application of the epoxy markings. Glass beads shall be applied immediately after application of the epoxy resin marking to provide an immediate no-track system.
14. The Contractor will place necessary "spotting" at appropriate points to provide horizontal control for striping and to determine necessary starting and cutoff points. Broken line intervals will not be marked. Longitudinal joints, pavement edges and existing markings shall serve as horizontal control when so directed.
15. A tolerance of 0.25 inch under or 0.25 inch over the specified width shall be allowed for striping provided the variation is gradual and does not detract from the general appearance. Alignment deviations from the control guide shall not exceed 2 inches provided the variation is gradual and does not detract from the general appearance. Material shall not be applied over a longitudinal joint. Establishment of application tolerances shall not relieve the Contractor of the responsibility to comply as closely as practicable with the planned dimensions.
16. Operations shall be conducted only when the road surface temperature is at least 40° F. They shall be discontinued during periods of rain, and shall not continue until the Construction Manager and/or Architect determines that the pavement surface is dry enough to achieve adhesion.
17. The epoxy shall be uniformly applied to the surface to be marked to ensure a wet film thickness of the applied epoxy, without glass beads, of 20 mils +/- 1 mil.
18. Glass beads conforming to the requirements of Grading "B" (larger beads) shall be applied at a rate of 12 pounds per gallon of epoxy pavement marking material, immediately followed by a second drop of glass beads conforming to the requirements of Grading "A" (smaller beads) applied at a rate of 13 pounds per gallon of epoxy pavement marking material. Traffic cones, barricades, or some other acceptable method shall be used to protect the pavement markings until cured.
19. The material shall be in "no-tracking" condition within 15 minutes, or as allowed by the Construction Manager and/or Architect. The no-tracking time shall be determined by passing over the line with a passenger car or pickup truck in the simulated passing maneuver. A marking showing no visual deposition of the material to the pavement surface when viewed from a distance of 50 feet shall be considered as showing "no-tracking" and conforming to this requirement for time to no-track.
20. When stencils are used during the application of epoxy markings, care must be used when removing the stencils so that the epoxy resin does not drip on the road, sidewalk, grass, etc., and so that the applied markings have edges which are clean, straight and neat.
21. Epoxy resin pavement markings may be applied over existing painted markings provided they are sufficiently worn to allow adequate adhesion. If required by the Construction Manager and/or Architect, existing plastic, thermoplastic, epoxy or freshly painted markings shall be removed prior to the application of epoxy markings.

C. Thermoplastic pavement markings, symbols, and legends
1. This item shall consist of furnishing and installing retroreflective white and yellow Thermoplastic pavement markings of the width and color specified pavement markings, symbols and legends at the locations indicated on the plans and in conformity with the plans, these specifications and as directed by the Construction Manager and/or Architect.
2. Thermoplastic pavement markings includes: stop bars, cross bars, cross walk bars, arrows, and legends.
3. Use equipment as required by manufacturer for this application. Before color is changed, equipment shall be cleaned out sufficiently to ensure that the color of material applied will be correct.

4. When working on a road it is contractor's responsibility for insuring vehicle and pedestrian traffic and worker's safety. Its cost shall be included in the bid price for this item.
5. For markings applied on pavements over one year old, equipment furnished shall also include a power washing machine capable of cleaning the pavement with a pressure of 2,400 to 2,800 psi with water heated to 180° F - 195° F. No chemicals shall be added to the water used in the process. The power washer shall be equipped with a turbo blast tip with an oscillating head and shall be capable of supplying a minimum of 5 gallons/minute gun.
6. All guns on the spray carriages shall be in full view of the operator(s) during operation.
7. Each vehicle furnished shall include at least one experienced operator, who shall be fully knowledgeable about all equipment operations and application techniques.
8. The Contractor shall also furnish one technical expert, who shall be fully knowledgeable about all equipment operations and application techniques, to oversee the project operation.
9. Pavement markings shall be applied in accordance with the details shown on the plans and the control points established by the Contractor and approved by the Construction Manager and/or Architect.
10. The road surface shall be cleaned at the direction of the Construction Manager and/or Architect just prior to application. Pavement cleaning shall consist of power washing using clean water heated to 180° F - 195° F at a pressure of 2,240 - 2,800 psi. The areas to be power washed shall include all areas where Thermoplastic marking symbols and legends are to be applied and at least 1 inch beyond the area to be marked. The surface shall be cleaned to the satisfaction of the Construction Manager and/or Architect. For other pavement areas, cleaning shall consist of brushing with rotary broom (non-metallic), and any additional work as recommended by the material manufacturer and acceptable to the Construction Manager and/or Architect. New Portland cement concrete surfaces shall be cleaned by abrasive blasting to remove any surface treatments and/or laitance. New bituminous concrete surfaces are not to be power washed.
11. All surfaces that are power washed shall be allowed to dry sufficiently prior to the application of the Thermoplastic markings. The areas to be marked shall be broom cleaned immediately prior to the application of the Thermoplastic markings.
12. First apply Smart SealTM or approved equal primer-sealer to Portland Concrete Cement (PCC) and aged asphalt according to manufacturer's recommended procedures. Make certain all solvent has evaporated and sealer has dried. Solvent left in the sealer will cause obstructions in the line commonly referred to as blistering and pin holing. If a sealer is applied at a heaver mil thickness, solvent can be trapped beneath the top dry film resulting in the same type of problem.
13. Smart SealTM or approved equal primer-sealer application:
    a. Apply Dobco Smart SealTM I (or approved equal) cold, to a clean and dry surface.
    b. Stir before use.
    c. When properly applied to produce a dry film thickness of 1 mil., one gallon will yield the following rates:

4-inch line	960 lineal feet
5-inch line	770 lineal feet
6-inch line	640 lineal feet
8-inch line	480-lineal feet

    d. Apply at least 1 inch wider than thermoplastic marking.
    e. The solvent should completely evaporate prior to thermoplastic application. Dry time is approximately 20 seconds at 77°F, but will vary according to climate conditions.
    f. Apply Smart SealTM I (or approved equal) and thermoplastic the same day.
    g. Clean Smart SealTM I (or approved equal) equipment with Xylol, Toluene or similar solvents.
14. Do not mix hydrocarbon and alkyd.
15. Use Smart Mark Alkyd White Thermoplastic or Solar Smart Yellow Thermoplastic payment makings by Dobco or approved equal.

a. Heat material to 400-440°F in equipment with agitation. At ambient temperatures of 50-60°F apply materials at 420-440°F. At ambient temperatures of 85-90°F apply materials at 400-430°F. For inlaid, recessed applications, when ambient temperatures are 50-90°F, materials can be extruded at 390-430°F, due to the increased application thickness.

b. Do not apply material to road surface at ambient temperatures below 50°F. Wind will cause material cooling in spray and ribbon gun applications. This may be compensated for by applying material at the upper end of the application range. During high road and ambient temperatures greater than 85°F, apply material at lower end of the application range (400-430°F) to facilitate cooling. Set times may increase slightly at temperatures exceeding 85°F.

16. Avoid contact with hot material. Do not breathe hot fumes. Heating material above 450°F may cause material to flash or ignite. Refer to material Safety Data Sheet (MSDS) for details.
17. Apply glass spheres uniformly using pressurized or gravity devices. Optimal rates of application range from 8 to 10 lbs/100ft^2 depending on application method and glass spheres used. Flooding of glass beads results in reduced retroreflectivity.
18. Hot molten thermoplastic will burn skin. Do not attempt to remove the thermoplastic from the skin. Cool under running water and seek medical attention immediately (refer to MSDS).
19. Always cover material and keep in a cool dry place.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that sub-grade is dry and in suitable condition to begin paving.

B. Proof-roll sub-grade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated sub-grades.
   1. Completely proof-roll sub-grade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
   2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
   3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Construction Manager and/or Architect, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 GENERAL

A. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.3 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of to be samples taken and identify on field and consult to Construction Manager for approval.
2. Mill to a uniform finished surface free of gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. separate from milled hot-mix asphalt.
7. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.
8. Transport milled hot-mix asphalt to asphalt recycling facility.
9. Keep milled pavement surface free of loose material and dust.
10. Do not allow milled materials to accumulate on-site.

3.4 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
   1. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
   2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

E. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.5 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
   1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch .

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.6 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared sub-grade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared sub-grade or surface of compacted-aggregate base before applying paving materials.
   1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.
   1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
   2. Protect primed substrate from damage until ready to receive paving.

D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.
   1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
   2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.7 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated in table below.
   2. Place hot-mix asphalt surface course in single lift and thicknesses indicated in table below.
   3. Spread mix at minimum temperature of 250 deg F.
   4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
   5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
   1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
   2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.8 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
   3. Offset transverse joints, in successive courses, a minimum of 24 inches.
   4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
   5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
   6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.9 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
   2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F .
   1. Asphalt Mix: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.11 ASPHALT TRAFFIC-CALMING DEVICES

A. sldf

B. Construct hot-mix asphalt speed bumps or elevated sidewalks over compacted pavement surfaces. Apply a tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F .
   1. Tack Coat Application: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
   2. Asphalt Mix: Same as pavement surface-course mix.
   3. Before installation, mill pavement that will be in contact with bottom of traffic-calming device. Mill to a depth of 1 inch from top of pavement to a clean, rough profile.

C. Place and compact hot-mix asphalt to cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.12 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
   1. Base Course: 1/4 inch.
   2. Surface Course: 1/8 inch.

3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Asphalt Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch of height indicated above pavement surface.

3.13 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.14 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Construction Manager and/or Architect.

B. Allow paving to age for 30 days before starting pavement marking.

C. Prepare surfaces as directed above.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.16 PAVEMENT WARRANTY:

A. The Contractor shall warrant and guarantee the quality of materials and workmanship to be free of any defects for a period of five years from the date of installation of asphalt pavement. This will include: any cracks larger than 1/8-inch wide will be filled with crack filler; tire scuff marks will be heated and re-tamped; and any heaving and/or sagging of the pavement in excess of the original installation specification tolerances. This Unconditional Warranty does not include damage caused by oil spills and normal wear and tear.

3.17 PAVEMENT MARKINGS ACCEPTANCE AND WARRANTY:

A. In order to be accepted, the applied markings must meet the following minimum retroreflectivity reading as measured using an LTL 2000 Retrometer with 30-meter geometry 1 to 2 weeks after installation:

B. White Epoxy 250 millicandelas per square foot per foot candle (millicandelas per square meter per lux)

C. Yellow Epoxy 175 millicandelas per square foot per foot candle (millicandelas per square meter per lux)

D. The Contractor shall warrant for the period and percentage level indicated below that the installation shall remain intact and serviceable. The installed material shall show no fading, lifting, shrinking, tearing, rollback, distortion or chipping due to vehicular traffic or normal maintenance activities including snow plowing. Although some wear is expected, the markings shall not wear out for the period and percentage level indicated below.

E. First Year

F. Epoxy Resin and Thermoplastic Pavement Markings 95% linear feet.

G. Epoxy Resin and Thermoplastic Pavement Markings, Symbols and Legends 95% square feet.

H. In addition, the epoxy resin pavement markings shall be warranted to retain a minimum retroreflective value of 150 millicandelas per foot candle (lux) per square foot (square meter) one year after installation. The measurements shall be made utilizing an LTL 2000 Retrometer with 30-meter geometry.

I. Determination of percentages of serviceability and minimum retroreflective values will be made jointly at the end of 1 year by the Contractor’s representative, the Construction Manager, and Architect. The decision of the Architect and Construction Manager shall be final. The term "percentage of serviceability" shall be defined as follows: The percentage of serviceability of the markings shall apply to the total linear feet for particular Pavement Markings and total square feet for the particular Pavement Markings, Symbols and Legends measured on the project for payment.

J. The Contractor shall replace, entirely at the Contractor’s expense, such amount of markings, if any, required to meet the above stated percentage. The Construction Manager and Architect will indicate the areas and lines to be replaced to meet the above stated percentages. The Contractor shall also replace

those markings that fail the minimum value for retroreflectivity. Replacement under either situation shall include all materials, equipment, labor and work incidental thereto.

K. The Contractor shall provide to the Owner, at no extra cost, any manufacturer's warranties or guarantees that exceed the minimum requirements stated previously, that are normally provided by the manufacturer.

L. These written warranties shall be provided when the documentation for the product is provided.

3.18 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in a CT DEP -approved landfill.
   1. Do not allow milled materials to accumulate on-site.

3.19 AS-BUILT

A. Final field As-built of all constructed items location and elevations by a CT Licensed Land Surveyor in paper, Mylar and AutoCad format to be provided for owner and engineer.

B. Final As-built of all items location and elevations .dwg file in AutoCAD Civil 3D format of as built prepared by a CT Licensed Land Surveyor with Civil 3D pipe networks.

END OF SECTION 32 12 16

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section “Summary.”

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include complying with CTHPB standards. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling and an indoor quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental compliance goals

1.3 SUMMARY

A. This Section includes exterior concrete paving for the following:
   1. Concrete Sidewalks and Ramps
   2. Concrete Walks.
   3. Concrete Curb
   4. Salt Guard Treatment

B. Related Sections include the following:
   1. Division 31 Section "Earth Moving" for subgrade preparation, grading, and sub-base course.
   2. Division 3, Section 033053 "Miscellaneous Cast-in-Place Concrete" for general building applications of concrete.
   3. Division 32, Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.4 REFERENCES

A. State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current edition and supplemental.

B. Town of Rocky Hill Details and Specifications.

1.5 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.6 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to concrete paving, including but not limited to, the following:
      a. Concrete mixture design.
      b. Quality control of concrete materials and concrete paving construction practices.
   2. Require representatives of each entity directly concerned with concrete paving 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 paving Subcontractor.

1.7 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

C. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

D. Shop Drawing: Scoring and Jointing Plan
   1. Plan to be submitted to Architect for review and approval showing the location of the following
      a. Construction Joints
      b. Isolation Joints
      c. Contraction Joint
      d. Scoring Pattern
   2. Shop drawing shall be reproduced at 1”=20’ and submitted in electronic .PDF and .dwg file format
   3. Other formats shall be subject to approval of the architect

E. Material Certificates: For the following, from manufacturer:
   1. Cementitious materials.
   2. Steel reinforcement and reinforcement accessories.
   3. Fiber reinforcement.
   4. Admixtures.
   5. Curing compounds.
   6. Applied finish materials.
   7. Bonding agent or epoxy adhesive.
   8. Joint fillers.

F. Material Test Reports for:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
2. Field quality-control reports

1.8 QUALITY ASSURANCE

A. Ready – Mix Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

C. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.

D. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.
   1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Construction Manager and/or Architect.
   2. Notify Construction Manager and/or Architect seven days in advance of dates and times when mockups will be constructed.
   3. Obtain Construction Manager and/or Architect's approval of mockups before starting construction.
   4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
   5. Demolish and remove approved mockups from the site when directed by Construction Manager and/or Architect.
   6. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."
   1. Before submitting design mixes, review concrete pavement mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with concrete pavement to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixes.
      c. Ready-mix concrete producer.
      d. Concrete subcontractor.

1.9 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
   1. Use flexible or curved forms for curves of a radius 100 feet or less. Do not used notched and bent forms.

B. 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.

2.3 STEEL REINFORCEMENT

A. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, plain steel.

B. Epoxy-Coated Reinforcement Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 deformed bars.

C. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 plain steel bars.

D. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

E. Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer coated wire bar supports.

G. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

2.4 CONCRETE MATERIALS

A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.

B. Regional Materials: Concrete shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

C. Concrete for curbing shall conform to the requirements of Section 8.11 and M.03 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current supplemental and Town of Rocky Hill standards, including current supplemental and the detail included on the plans.

D. Concrete for sidewalks, ramps, and walks shall conform to the requirements of Section 9.21 and 9.24, and M.02, M.03, and M.06 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current supplemental and Town of Rocky Hill standards, including current supplemental and the detail included on the plans.

E. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

F. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

G. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

H. Epoxy-Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

I. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

J. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
1. Color: As selected by Architect from manufacturer's full range.

2.5 Salt Guard

A. Manufacturer: PROSOCO, Inc., 3741 Greenway Circle, Lawrence, KS 66046. Phone: (800) 255-4255; Fax: (785) 830-9797. E-mail: CustomerCare@prosoco.com

B. Product Description
1. PROSOCO Saltguard® WB is a ready-to-use water-based, VOC compliant silane/siloxane water repellent and “chloride screen” for the protection of concrete and masonry surfaces.
2. Saltguard® WB protects surfaces from moisture intrusion and chemical attack of chloride salts.
3. Saltguard® WB is appropriate for use on horizontal surfaces such as driveways, sidewalks, and tile, brick and sandstone pavers, as well as providing excellent protection for retaining walls, bridge pilings and other vertical surfaces exposed to de-icing salts.

C. Typical Technical Data
1. FORM: White, odorless liquid
2. SPECIFIC GRAVITY: 0.997
3. pH: 7 to 8
4. WEIGHT/GALLON: 8.24 pounds
5. ACTIVE CONTENT: 5 percent
6. TOTAL SOLIDS: 4.2 percent
7. FLASH POINT: greater than 212 degrees F (greater than 100 degrees C)
8. FREEZE POINT: 32 degrees F (0 degrees C)
9. VOC CONTENT: less than 25 grams per Liter Low Solids Coating. Complies with all known national, state and district AIM VOC regulations.

D. Limitations
1. Not for use on natural stone, except sandstone.
2. Do not apply at temperatures above 95 degrees Fahrenheit (35 degrees Celsius). Higher temperatures evaporate the water carrier which may result in an uneven appearance.
3. Always test for proper penetration when applying to tightly troweled concrete, such as garage floors.
4. Will not prevent water penetration through structural cracks, defects or open joints.
5. Not suitable for application to coated surfaces or surfaces previously treated with water repellents or liquid hardeners.
6. Water repellency of treated surfaces will increase for up to 14 days after application.
7. Not suitable for protecting surfaces subjected to constant water spray (car washes).
8. Not suitable for application to synthetic resin paints, gypsum or other non-masonry surfaces.
9. May not be suitable for surfaces to receive paints or coatings. Always test for compatibility.
10. Not recommended for below-grade application.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
   1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
   2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
   3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."

C. Remove loose material from compacted sub-base surface immediately before placing concrete.

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

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.
   1. Apply epoxy repair coating to uncoated or damaged surfaces of epoxy-coated reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

F. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap to adjacent mats.

3.4 JOINTS

A. General: Construct construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
   1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.
   1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
   2. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
   3. Provide tie bars at sides of pavement strips where indicated.
   4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   5. Use epoxy bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   6. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
   1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
   2. Extend joint fillers full width and depth of joint.
   3. Terminate joint filler less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
   4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
   5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
   6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
      a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
   2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch. wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
      a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

F. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in.

B. Remove snow, ice, or frost from sub-base surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten sub-base to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements and with recommendations in ACI 301 for measuring, mixing, transporting, and placing concrete.
1. Do not add water to concrete during delivery, at Project site, or during placement. Do not add water to fresh concrete after testing.

E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

F. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping.
1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

G. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or derbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

H. Rigid Concrete Pavement Section: When concrete is used for the pavement subjected to heavy trucks, rigid concrete pavement shall be used. Concrete shall be 5 inches thick and reinforced with a minimum reinforcement consisting of 6x6-w2.0xW2.0 welded wire or equivalent. Dowels should be placed across slab expansion joints to limit differential settlements. The outer edges of concrete pavement are susceptible to damage as trucks move from the concrete to the adjacent bituminous concrete. Therefore, the concrete thickness of the outer 2 feet of the concrete pavement should be increased to 12 inches. Concrete pavements should be protected from construction traffic until a compressive strength of at least 2,500 psi has been achieved. The above sections represent minimum thicknesses and, as such, periodic maintenance should be anticipated. Concrete for rigid pavements should be air-entrained and placed with a maximum slump of 4 inches. Proper joint spacing will be required to reduce the likelihood of slab curling and shrinkage cracking. Joint spacing not to exceed 10 to 12 feet. Joints

shall be sealed to reduce the likelihood of entry of foreign material. Concrete shall be in accordance with the specifications of CTDOT Form 817, M.03.01. Portland cement shall be Type I or II, f'c=4,000 psi.

I. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

J. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.
   1. Compact sub-base and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

K. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

L. 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 air temperature has fallen to or is expected to fall below 40 deg F , uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

M. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F. 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. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   3. Fog-spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.6 CONCRETE FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.
   1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven 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. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.8 Salt Guard Installation.

A. Application: Before applying, read “Preparation” and “Safety Information” sections in the Manufacturer’s Product Data Sheet for PROSOCO Saltguard® WB. Refer to the Product Data Sheet for additional information about application of Saltguard® WB. Do not dilute or alter. Mix well before application.

B. Test Area: Test a minimum 4 ft. by 4 ft. area on each type of masonry. Use the manufacturer’s application instructions. Let test area protective treatment cure before inspection. Keep test panels available for comparison throughout the protective treatment project.

C. VERTICAL APPLICATION INSTRUCTIONS
   1. For best results, apply Saltguard® WB “wet-on-wet” to a visibly dry and absorbent surface.
   2. Spray: Saturate from the bottom up. Apply enough for a 4 to 8 inch (15 to 20 centimeter) rundown below the spray contact point. Let the first application penetrate for 5 to 10 minutes. Reapply in the same saturating manner. Less material will be needed for the second application.
   3. Brush or Roller: Apply uniformly. Saturate the surface. Let Saltguard® WB penetrate for 5 to 10 minutes. Brush out heavy runs and drips that do not penetrate.
   4. Brush or roller application is recommended for small scale application or locations where use of high-volume, low pressure sprayers is not appropriate.

D. HORIZONTAL APPLICATION INSTRUCTIONS
   1. Apply Saltguard® WB in a single saturating application. Use enough to keep the surface wet for 2 to 3 minutes before penetrating. Do not over apply.
   2. Broom out all puddles thoroughly until they penetrate the surface. Wipe up all excess material.
   3. Always test for proper penetration on tightly troweled concrete, such as garage floors. The tight finish or residual curing and sealing compound(s) may interfere with Saltguard® WB's ability to penetrate the surface.

E. DENSE SURFACE APPLICATION INSTRUCTIONS
   1. Apply a single coat. Use enough to completely wet the surface without creating drips, puddles or rundown. Do not over apply. Test for application rate.
   2. Test for proper penetration on tightly troweled concrete, such as garage floors. The tight finish or residual curing and sealing compound(s) may interfere with Saltguard® WB's ability to penetrate the surface.

F. Treated surfaces will dry to touch within 1 hour. Protect surfaces from rainfall for a minimum of 6 hours following treatment. Treated surfaces will be ready for pedestrian and vehicle traffic in 24 hours. Water repellency of treated surfaces will increase for up to 14 days after application.

G. Cleanup: clean tools, equipment and surfaces affected by over spray with soap and warm water.

3.9 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:
   1. Elevation: 1/4 inch.
   2. Thickness: Plus 3/8 inch, minus 1/4 inch.
   3. Surface: Gap below 10-foot long, unleveled straightedge not to exceed 1/2 inch.
   4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
   5. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
   6. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
   7. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
   8. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
   9. Joint Spacing: 3 inches.
   10. Contraction Joint Depth: Plus 1/4 inch, no minus.
   11. Joint Width: Plus 1/8 inch, no minus.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Construction Manager and/or Architect.

B. Allow concrete pavement to cure for 30 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils for Epoxy markings and 90 mils for Thermoplastic markings.

1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal for Epoxy markings.
2. For more information on paint markings see Section 32 12 16 – Asphalt Paving spec.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement.
   1. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
   2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or 5000 sq. ft. or fraction thereof of each concrete mixture placed each day.
      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   3. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   4. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   5. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
   6. Compression Test Specimens: ASTM C 31; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
   7. Compressive-Strength Tests: ASTM C 39; test one specimen at seven days and two specimens at 28 days.
      a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
      b. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
      c. When total quantity of a given class of concrete is less than 50 cu. yd., Construction Manager or Architect may waive compressive-strength testing if adequate evidence of satisfactory strength is provided.
      d. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.

B. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi.

C. Test results shall be reported in writing to Construction Manager and/or 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 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. The testing laboratory must declare conformance or otherwise to the design specifications.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Construction Manager and/or Architect but will not be used as the sole basis for approval or rejection.

F. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Construction Manager and/or Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section. . Remove work in complete sections from joint to joint unless otherwise approved by Construction Manager and/or Architect.

B. Drill test cores where directed by Construction Manager and/or Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

3.13 AS-BUILT

A. Final field As-built of all constructed items location and elevations by a CT Licensed Land Surveyor in paper, Mylar and AutoCad format to be provided for owner and engineer.

B. Final As-built of all items location and elevations .dwg file in AutoCAD Civil 3D format of as built prepared by a CT Licensed Land Surveyor with Civil 3D pipe networks.

END OF SECTION 32 13 13

SECTION 321373 – CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include complying with CTHPB standards. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling and an indoor quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental compliance goals

1.3 SUMMARY

A. This Section includes the following:
1. Expansion and contraction joints within cement concrete pavement.
2. Joints between cement concrete and asphalt pavement.
3. Cold-applied joint sealants.
4. Hot-applied joint sealants.
5. Joint-sealant backer materials.
6. Primers.

B. Related Sections include the following:
1. Division 32, Section 321216 " Asphalt Paving" for constructing joints between concrete and asphalt pavement.
2. Division 32, Section 321313 "Concrete Paving" for constructing joints in concrete pavement.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Paving-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.

C. Qualification Data: For Installer.

D. Product Certificates: For each type of joint sealant and accessory.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

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.
   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.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, 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. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type SL.

C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.

D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.

E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.

2.3 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I.

B. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I or Type II.

C. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I, II, or III.

D. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type IV.

2.4 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

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.
   1. 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.
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests 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.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backings to support joint 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 joint-sealant backings.
   2. Do not stretch, twist, puncture, or tear joint-sealant backings.
   3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
   1. Place joint sealants so they fully contact 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.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements 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 joint sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved 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 and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

3.6 PAVING-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within concrete paving.
   1. Joint Location:
      a. Expansion and isolation joints in concrete paving.
      b. Contraction joints in concrete paving.
      c. Other joints as indicated.
   2. Joint Sealant:
      a. Single-component, nonsag, silicone joint sealant
      b. Single-component, self-leveling, silicone joint sealant
      c. Multicomponent, nonsag, urethane, elastomeric joint sealant
      d. Single component, pourable, urethane, elastomeric joint sealant
      e. Multicomponent, pourable, urethane, elastomeric joint sealant
      f. Hot-applied, single-component joint sealant.
   3. Joint-Sealant Color: Manufacturer's standard.

B. Joint-Sealant Application: Joints within concrete paving and between concrete and asphalt paving.
   1. Joint Location:
      a. Joints between concrete and asphalt paving.
      b. Joints between concrete curbs and asphalt paving.
      c. Other joints as indicated.
   2. Joint Sealant:
      a. Hot-applied, single-component joint sealant.
   3. Joint-Sealant Color: Manufacturer's standard.

END OF SECTION 32 13 73

SECTION 323113 - CHAIN LINK FENCES AND GATES

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. Chain-link fences.
   2. Privacy slats.

B. Related Requirements:
   1. Section 033053 "Miscellaneous Cast-in-Place Concrete" for cast-in-place concrete post footings.
   2. Section 312000 “Earth Moving” for filling and grading work.

1.3 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 the following:
      a. Fence and gate posts, rails, and fittings.
      b. Chain-link fabric, reinforcements, and attachments.
      c. Accessories: Privacy slats.
      d. Gates and hardware.

B. Shop Drawings: For each type of fence and gate assembly.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Include accessories, hardware, gate operation, and operational clearances.

C. Samples for Initial Selection/Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:
   1. Polymer-Coated Components: In 6-inch (150-mm) lengths for components and on full-sized units for accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate hardware.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has at least three years' experience and has completed at least five chain link fence projects with same material and of similar scope to that indicated for this Project with a successful construction record of in-service performance.

B. Single-Source Responsibility: Obtain chain link fences and gates, including accessories, fittings, and fastenings, from a single source.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Failure to comply with performance requirements.
   b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.
1. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.
   a. Design Speed: 110 mph.
   b. Exposure Category: B
   c. Fence Height: 6’, 8’ and 12’
   d. Material Group: IA, ASTM F1083, Schedule 40 Steel Pipe

B. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: Full fence height, limited to 12 feet.
2. Steel Wire for Fabric: Wire diameter of 0.192 inch (4.88 mm).
    a. Mesh Size: 2 inches (50 mm).
    b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 2, 2.0 oz./sq. ft. (610 g/sq. m)] with zinc coating applied after weaving.
    c. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: Knuckled at both selvages.

2.3 FENCE FRAMEWORK

A. Posts and Rails: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043/ ASTM F 1083 based on the following:

1. Fence Height: As indicated on Drawings no less than 6’.
2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40, minimum yield strength 30,000 psi.
    a. Line Post: 2.375 inches (60 mm) in diameter for fences 4-feet to 8-feet in height; 2.875 inches (73 mm) in diameter for fences 6-feet to 12-feet in height.
    b. End, Corner, and Pull Posts: 2.875 inches (73 mm) in diameter for fences 4-feet to 8-feet in height; 4.0 inches (102 mm) in diameter for fences 8-feet to 12-feet in height.
3. Horizontal Framework Members: Intermediate and top rails according to ASTM F 1043.
    a. Top Rail: 1.66 inches (42 mm) in diameter.
4. Brace Rails: ASTM F 1043.
5. Metallic Coating for Steel Framework:
    a. Type A: Not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating according to ASTM A 653/A 653M.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824, with the following metallic coating:
1. Type II: Zinc coated (galvanized) by hot-dip/electrolytic process, with the following minimum coating weight:
    a. Class 4: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of uncoated wire surface.

2.5 SWING GATES

A. General: ASTM F 900 for gate posts and single and double swing gate types.
1. Gate Leaf Width: As indicated.
2. Space frame members no greater than 8’ vertically and horizontally

3. Welded joints to be protected by applying zinc rich paint in accordance with ASTM A 780.

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F 1043/1083; protective coating and finish to match fence framework.
2. Gate Posts: Round tubular steel ASTM F 1083 schedule 40 galvanized pipe. Gate posts diameter to match that of terminal posts, diameter indicated on plan, or as indicated in the following table whichever is greatest;

Gate Fabric Up to and Including 6 feet	
Gate Leaf Width	Post Outside Diameter
Up to 4 feet	2.375 inches
Over 4 feet to 10 feet	2.875 inches
Over 10 feet to 16 feet	4.000 inches
Gate Fabric over 6 feet to 12 feet	
Up to 6 feet	2.875 inches
Over 6 feet to 12 feet	4.000 inches

3. Gate Frames and Bracing: Galvanized steel welded 1.900 in OD ASTM F 1083 schedule 40 pipe.

C. Frame Corner Construction: Welded.

D. Hardware:
1. Hinges: 360-degree inward and outward swing. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges.
2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Drop Bar to hold gate leaves open, one per gate.
4. Lock: Manufacturer's standard internal device.

2.6 FITTINGS

A. Provide fittings according to ASTM F 626.
1. Steel and Iron: Unless specified otherwise, hot-dip galvanize pressed steel or cast-iron fence fittings and accessories with at least 1.2 oz. zinc per sq. ft. as determined by ASTM A 90.

B. Post Caps: Provide for each post.
1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:
1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches (152 mm) long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate rails to posts.

E. Tension and Brace Bands: 3/4 inch wide minimum pressed steel band hot dip galvanized with a minimum of 1.2 oz. of zinc coating per sq. ft. and complying with the following
1. Tension Bands: .074 inch thick (14 gauge) minimum
2. Brace Bands: .105 inch thick (12 gauge) minimum.

F. Tension Bars: Steel, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
1. In compliance with ASTM F626, 3/8 in. (9.53 mm) diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.2 oz/ft² (366 g/m²), assembly capable of withstanding a tension of 2,000 lbs. (970 kg).

H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
1. Standard Round Wire: For attaching chain-link to posts, rails, and frames complying with the following
a. Hot dip galvanized steel: .106 inch diameter wire (12 gauge); galvanized A minimum of 0.80 oz/ft 2(230 g/m2) of zinc in accordance with ASTM A 641 (A 641M), Class 3 or A coating

2.7 PRIVACY SLATS

A. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than 0.06 inch (1.5 mm) thick, sized to fit mesh specified for direction indicated, with vandal-resistant fasteners and lock strips.

B. Tubular Polyethylene Slats: Minimum 0.023-inch (0.58-mm)-thick tubular polyethylene, manufactured for chain-link fences from virgin polyethylene with UV inhibitor, sized to fit mesh specified for direction indicated, with vandal-resistant fasteners and lock strips.

C. Color: As selected by Architect from manufacturer's full range.

2.8 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.
1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
   a. Concealed Concrete: Place top of concrete 2 inches (50 mm) below grade to allow covering with surface material.
   b. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
   c. Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches (127 mm) deep and 3/4 inch (20 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more. For runs exceeding 500 feet (152 m), space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at 10 feet (3 m) o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches (152 mm) of bottom of fabric and tie to each post with not less than same diameter and type of wire.

H. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to [outside] [inside] of enclosing framework. Leave [1-inch (25-mm)] [2-inch (50-mm)] bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches (380 mm) o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
1. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.

M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

N. Privacy Slats: Install slats in direction indicated, securely locked in place.
1. Vertically, for privacy factor of 70 to 75.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GROUNDING AND BONDING

A. Fence and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals of 1500 feet (450 m).

3. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m).
4. Ground fence on each side of gates and other fence openings.
   a. Bond metal gates to gate posts.
   b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (457 mm) below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of 150 feet (45 m) on each side of crossing.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

D. Connections:
1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
4. Make above-grade ground connections with mechanical fasteners.
5. Make below-grade ground connections with exothermic welds.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

E. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

3.6 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

3.8 AS-BUILT

A. Final As-built of all items location and elevations prepared by a CT Licensed Land Surveyor in paper, Mylar and AutoCad format signed and sealed accuracy class A-2/T-2 for owner and engineer.

END OF SECTION 323113

SECTION 32 31 19 - DECORATIVE METAL FENCES AND GATES

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. Decorative metallic-coated-steel tubular picket fences.
2. Decorative steel fences.
3. Decorative aluminum fences.
4. Swing gates.

B. RELATED SECTIONS
1. Section 31 10 00 - Site Clearing.
2. Section 03 30 00 - Cast-in-Place Concrete.

1.3 REFERENCES

A. ASTM International (ASTM):
1. ASTM B 221/B 221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
4. ASTM D523 - Test Method for Specular Gloss.
5. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
6. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
7. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
8. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
9. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
10. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.
11. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

B. American Architectural Manufacturers Association (AAMA): AAMA 2603 - Voluntary Specification, Performance Requirements, and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.

C. American Welding Society (AWS):
1. AWS D1.1 - Structural Welding Code - Steel (copyrighted by AWS, ANSI approved).
2. AWS D1.2 - Structural Welding Code - Aluminum (copyrighted by AWS, ANSI approved).

1.4 SUBMITTALS

A. Product Data: Submit product data showing materials proposed for use. Submit sufficient information to determine compliance with the Drawings and Specifications.

B. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data.

C. Samples:
1. Submit samples for initial color selection. Submit samples of each specified finish. Submit samples in form of manufacturer's color charts showing full range of colors and finishes available. Where finishes involve normal color variations, include samples showing the full, range of variations expected.
2. Submit samples for verification purposes. Additional samples may be required to show fabrication techniques and workmanship. Samples shall be submitted prior to installation.

D. Closeout Submittals: Submit the following:
1. Maintenance and operation data, including methods for maintaining installed products, and precautions against cleaning materials and methods detrimental to finishes and performance.
2. Warranty documents specified herein.

1.5 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of ornamental metal fences and gates of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of five years.
2. Installer Qualifications: Installer shall be a firm that shall have a minimum of two years of successful installation experience with projects utilizing ornamental metal fences and gates similar in type and scope to that required for this Project.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.
1. Welding Standards: Comply with applicable provisions of AWS D1.1 and AWS D1.2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

C. Single Source Responsibility: Obtain ornamental metal fences and gates from a single source with resources to produce products of consistent quality in appearance and physical properties without delaying the work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. 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 lot number, if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.7 PROJECT CONDITIONS

A. Field Measurements: Take field measurements prior to fabrication of the work and preparation of shop drawings, to ensure proper fitting of the work. Show recorded measurements on final shop

drawings. Notify the Owner and the Architect, in writing, of any dimensions found which are not within specified dimensions and tolerances in the Contract Documents, prior to proceeding with the fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the work.

1.8 WARRANTY

A. All structural fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

B. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for five (5) years from date of original purchase.

PART 2 PRODUCTS

2.1 DECORATIVE METALLIC-COATED-STEEL TUBULAR PICKET FENCES

A. Decorative Metallic-Coated-Steel Tubular Picket Fences: Comply with ASTM F 2408 for light-industrial (commercial) application (class) unless otherwise indicated.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Ameristar Perimeter Security, USA; an ASSA ABLOY company; Montage II® Majestic™ Welded Ornamental Steel Fence Series or comparable product by one of the following:

C. Posts:

1. End and Corner Posts: Shall be minimum Square tubes 2-1/2 by 2-1/2 inches (64 by 64 mm) and per the following table;

Table 1 – Minimum Sizes for Montage II Posts	
Fence Posts	Panel Height
2-1/2” x 12 Ga.	Up to & Including 6’ Height
3” x 12 Ga.	Over 6’ Up to & Including 8’ Height

2. Posts at Swing Gate Openings: Shall be per the following table.

Table 2 – Minimum Sizes for Montage II Gate Posts			
Gate Leaf	Gate Height		
	Up to & Including 4’	Over 4’ Up to & Including 6’	Over 6’ Up to & Including 8’
Up to 4’	2-1/2” x 12 Ga.	3” x 12 Ga.	3” x 12 Ga.
4’1” to 6’	3” x 12Ga.	4” x 11 Ga.	4” x 11 Ga.
6’1” to 8’	3” x 12 Ga.	4” x 11 Ga.	6” x 3/16”
8’1” to 10’	4” x 11 Ga.	6” x 3/16”	6” x 3/16”
10’1” to 12’	4” x 11 Ga.	6” x 3/16”	6” x 3/16”
12’1” to 14’	4” x 11 Ga.	6” x 3/16”	6” x 3/16”
14’1” to 16’	6” x 3/16”	6” x 3/16”	6” x 3/16”

D. Post Caps: Formed from steel sheet and hot-dip galvanized after forming.

E. Rails: Double-wall channels.
   1. Size: 1-3/4 by 1-3/4 inches (45 by 45 mm).
   2. Metal and Thickness: 0.104-inch (2.64-mm) nominal-thickness, hot-dip galvanized after fabrication.

F. Pickets: 1" Square by 14 gauge tubes.
   1. Terminate tops of pickets at top rail for flush top appearance.
   2. Picket Spacing: 3-3/4" clear, maximum.
   3. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by Ameristar's proprietary fusion welding process, thus completing the rigid panel assembly

G. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers.

H. Metallic-Coated Steel Sheet: Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi (310 MPa) and a minimum zinc (hot-dip galvanized) coating weight of 0.90 oz/ft2 (276 g/m2), Coating Designation G-90.

I. Galvanizing: For components indicated to be galvanized and for which galvanized coating is not specified in ASTM F 2408, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

J. Finish: The manufactured panels and posts shall be subjected to an inline electrodeposition coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm). The color shall be Black. The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic as follows;

   1. Adhesion: ASTM D 3359 Method B – Adhesion over 90% of test area (Tape and knife test)
   2. Corrosion Resistance: ASTM B117, D714, and D1654 – Corrosion resistance over 1,500 hours (Scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters)
   3. Impact Resistance: ASTM D 2794 - Impact Resistance over 60 inch lb. (Forward impact using 0.625" ball).
   4. Weathering Resistance: ASM D822, D2244, and D523 (60° Method) - Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

2.2 SWING GATES

A. Swing gates shall be fabricated using 1.75" x 14ga Forerunner double channel rail, 2" sq. x 12ga. gate ends, and 1" sq. x 14ga. pickets. Gates that exceed 6' in width will have a 1.75" sq. x 14ga. intermediate upright. All rail and upright intersections shall be joined by welding. All picket and rail intersections shall also be joined by welding. Gusset plates will be welded at each upright to rail intersection. Cable kits will be provided for additional trussing for all gates leaves over 6'.

B. Pedestrian swing gates shall be self-closing, having a gate leaf no larger than 48" width. Integrated hinge-closer set (2 qty) shall be ADA compliant that shall include a variable speed and final snap adjustment with compact design (no greater than 5" x 6" footprint). Hinge-closer set (2 qty) shall be tested to a minimum of 500,000 cycles and capable of self-closing gates up to a maximum gate weight of 260 lbs. and maximum weight load capacity of 1,500 lbs. Hinge-closer device shall be

externally mounted with tamper-resistant security fasteners, with full range of adjustability, horizontal (.5” - 1.375”) and vertical (0 - .5”). Maintenance free hinge-closer set shall be tested to operate in temperatures of negative 20 F to 200 F degrees, and swings to negative 2 degrees to ensure reliable final lock engagement.

C. Hardware
   1. Ameristar or approved equal for latches permitting operation from both sides with the ability to be locked with a pad lock

2.3 ALUMINUM

A. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.
   1. Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
   2. Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
   3. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
   4. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
   5. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.4 STEEL AND IRON

A. Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.

C. Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

D. Bar Grating: NAAMM MBG 531.
   1. Bars: Hot-rolled steel strip, ASTM A 1011/A 1011M, Commercial Steel, Type B.
   2. Wire Rods: ASTM A 510/A 510M.

E. Uncoated Steel Sheet: Hot-rolled steel sheet, ASTM A 1011/A 1011M, Structural Steel, Grade 45 (Grade 310) or cold-rolled steel sheet, ASTM A 1008/A 1008M, Structural Steel, Grade 50 (Grade 340).

F. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 50 (Grade 340), with G90 (Z275) coating.

G. Castings: Either gray or malleable iron unless otherwise indicated.
   1. Gray Iron: ASTM A 48/A 48M, Class 30.
   2. Malleable Iron: ASTM A 47/A 47M.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Division 03 Section "Misc. Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.

PART 3 EXECUTION

3.1 EXAMINATION

A. 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 Architect, 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.
   1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.
   2. Do not begin installation before final grading is completed unless otherwise permitted by architect.

3.2 PREPARATION

A. Prepare the grade and remove surface irregularities, if any, which may cause interference with the installation of the fence.

3.3 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 36 inches (600 mm) plus 3 inches (75 mm) for each foot (300 mm) or fraction of a foot (300 mm) that fence height exceeds 4 feet (1.2 m).

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
      a. Concealed Concrete: Top 2 inches (51 mm) below grade to allow covering with surface material. Slope top surface of concrete to drain water away from post.
   3. Posts Set in Concrete: Extend post to within 6 inches (150 mm) of specified excavation depth, but not closer than 3 inches (75 mm) to bottom of concrete.

D. Post Spacing: Set and install posts no more than 8’ on center and per the following table

TABLE 3						
Span	Montage II MAJESTIC - 8’ Nominal (92-5/8” Rail)					
Post Size	2-1/2”	3”	2-1/2”	3”	2-1/2”	3”
Bracket Type	Industrial Universal 2.5” (BB302) 3” (BB303)		Industrial Flat Mount (BB301)		Industrial Swivel (BB304)*	
Post Settings ± ½” O.C.	96”	96-1/2”	96”	96-1/2”	*96”	*96-1/2”

   1. *Note: When using BB304 swivel brackets on either or both ends of a panel installation, care must be taken to ensure the spacing between post and adjoining pickets meets applicable codes. This will require trimming one or both ends of the panel.

E. For installations that must be raked to follow sloping grades, the post spacing dimension must be measured along the grade. Fence panels shall be attached to posts with brackets supplied by the manufacturer.

3.4 FENCE INSTALLATION MAINTENANCE

A. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces; 1) Remove all metal shavings from cut area. 2) Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry. 3) Apply 2 coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty.

B. Ameristar spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Ameristar parts or components will negate the manufactures' warranty.

3.5 GATE INSTALLATION

A. Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application; weight, height, and number of gate cycles.

B. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacturer of the gate and shall be installed per manufacturer's recommendations.

3.6 ADJUSTING AND CLEANING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Touch-up, repair, or replace damaged products before Substantial Completion.

C. Clean the work according to manufacturer's written instructions. The Contractor shall clean the job site of excess materials. Post hole excavations shall be scattered uniformly away from the posts. Clean fence with mild household detergent and rinse well with clean water. Mortar shall be removed from exposed posts using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.

3.7 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
   1. Fences within 100 feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
   2. Gates and Other Fence Openings: Ground fence on each side of opening. Bond metal gates to gate posts.

B. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

C. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

D. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

E. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.8 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the work shall be without damage at time of Substantial Completion.

END OF SECTION

SECTION 32 31 21 - ALUMINUM LOUVER FENCING AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Ornamental fixed louver modular fencing panels fabricated with extruded aluminum louvers and flat aluminum bars including extruded aluminum fence posts and aluminum louver gates.

B. Related sections:
   1. Section 03 30 00 - Cast-in-Place Concrete: Concrete footings for support of fence posts.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM) Publications:
   1. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
   2. ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.
   3. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
   4. ASTM D822 - Tests on Paint and Related Coatings Using Filtered Open-Flame Carbon-Arc Exposure Apparatus.
   5. ASTM D1794 - Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   6. ASTM D3363 - Test Method for Film Hardness by Pencil Test.

1.3 SUBMITTALS

A. Provide in accordance with Section 01 33 00 - Submittal Procedures:
   1. Product data for components and accessories.
   2. Shop drawings showing layout, dimensions, spacing of components, and anchorage and installation details.
   3. Sample: 8 by 10 inches minimum size sample of fence panel illustrating design, fabrication workmanship, and selected color coating.
   4. Copy of warranty specified in Paragraph 1.4 for review by Architect.

1.4 WARRANTY

A. Provide in accordance with Section 01 77 00 - Closeout Procedures:
   1. 20 years warranty for factory finish against cracking, peeling, and blistering under normal use.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Ametco® Manufacturing Corporation, 4326 Hamann Parkway, P.O. Box 1210, Willoughby, Ohio 44096; 800-362-1360.

B. Requests to use equivalent products of other manufacturers shall be submitted in accordance with Section 01 63 00 - Product Substitution Procedures.

2.2 MATERIALS

A. Extruded aluminum: ASTM B221, Alloy 6063, Temper T-6.

B. Sheet aluminum: ASTM B209 6063, Temper T-6.

C. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, and water reducing and plasticizing additives.

2.3 FENCE SYSTEM

A. Type: Ornamental fencing system consisting of vertical, fixed louver, modular fence panels fabricated with extruded aluminum framing bars and supported by extruded aluminum fence posts; Saturn Aluminum Fixed Louver Fencing as manufactured by Ametco® Manufacturing Corporation.

B. Fence panel:
1. Fixed louver bars: Two rows of Extruded aluminum tube, 1/2 inch x 4 inches wide, spaced at 4 inches for 100 percent visual screening.
2. Cross bars: 1/2 by 1/8 inch flat bars welded perpendicular to back side of louver bars and spaced at 18 inches
3. Panel height: 48 inches.
4. Panel width: 64-21/32 inches or custom size as indicated on plans/details

C. Line Posts: Extruded aluminum solid shapes.
1. Size: 3”x3”x 3/16 inch.
2. Length: 11.5 feet..

2.4 GATES

A. Provide gates of type and size indicated on Drawings. Equip gates with manufacturer's standard hardware as required for complete functional operation.

B. Type: Hinged swinging double gate.
1. Construction: Welded frame fabricated from extruded aluminum tubing with aluminum fixed louver panels to match fencing material.
2. Nominal size: 8 wide by 8 high.
3. Hardware:
   a. Hinges: Size and type as determined by manufacturer. Provide 2 hinges for each leaf up to 6 feet high and 1 additional hinge for each additional 24 inches in height or fraction thereof.
   b. Latch: 3/4 inch diameter slide bolt to accommodate padlock.
   c. For double gates provide padlockable, 5/8 inch diameter center cane bolt assembly and strike.

2.5 ACCESSORIES

A. Fasteners: Stainless steel bolts of type, size, and spacing as recommended by fence manufacturer for specific condition.

2.6 FACTORY FINISH

A. Aluminum fence panels and posts shall receive polyester powder coating. Large gate panels shall be coated with 2-part polyurethane coating.

B. Polyester powder coating: Electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.
1. Minimum hardness measured in accordance with ASTM D3363: 2H.
2. Direct impact resistance tested in accordance with ASTM D2794. Withstand 160 inch-pounds.
3. Salt spray resistance tested in accordance with ASTM B117: No undercutting, rusting, or blistering after 500 hours in 5 percent salt spray at 95 degrees F and 95 percent relative humidity and after 1000 hours less than 3/16 inch undercutting.
4. Weatherability tested in accordance with ASTM D822: No film failure and 88 percent gloss retention after 1 year exposure in South Florida with test panels tilted at 45 degrees.

C. Polyurethane coating: 1.0 mil dry film thickness of coating of test panel cured 30 minutes at 180 degree F and aged 14 days shall resist the following test conditions without failure:
1. 5 percent salt spray for 500 hours.
2. 100 percent relative humidity for 1000 hours.
3. Water immersion for 100 hours.
4. 20 double rubs with cloth saturated with either lacquer thinner, acetone, MEK, gasoline, xylene.
5. Exposure to lubricating oils, hydraulic fluids, and cutting oils.
6. 16 cycles of 24 hours at 100 percent humidity, 24 hours at 10 degrees F, and 24 hours at 77 degrees F.
7. Hardness: H to 2H.
8. Flexibility: 1/8 inch conical mandrel.

D. Color: Selected by Architect from manufacturer's standard range.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to fabrication, field verify required dimensions.

B. Cast concrete footings in accordance with Section 03 30 00 - Cast-in-Place Concrete as detailed on Drawings and approved shop drawings.
1. Minimum footing diameter:
   a. Terminal Posts: 12 inches
   b. Gate Posts: 24 inches
   c. Intermediate line posts: 12 inches
2. Allow 36 inch minimum embedment of posts.
3. Allow 6 inches minimum concrete beneath post bottom.

C. Provide setting holes for embedment of fence posts.

3.2 INSTALLATION

A. Install fencing in accordance with manufacturer's installation instructions and approved shop drawings.

B. Install fence posts plumb and level by setting post in hole cast in concrete and grouting solid by embedding post directly in concrete footing. Temporarily brace fence posts with 2 by 4 wood supports until concrete is set.

C. Do not installed bent, bowed, or otherwise damaged panels. Remove damaged components from site and replace.

D. Secure fence panels with standard stainless steel bolts to fence posts.

E. Gates:
   1. Install gates and adjust hardware for smooth operation.
   2. Provide concrete center foundation depth and drop rod retainers at center of double swinging gate openings.

F. Touch-up damaged finish with paint supplied by manufacturer and matching original coating.

END OF SECTION

SECTION 323215 - PRECAST MODULAR BLOCK GRAVITY RETAINING WALL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes furnishing all materials and labor required for the design and construction of a precast concrete modular block (PMB) retaining wall without geosynthetic reinforcement. Precast modular block retaining wall blocks under this section shall be cast utilizing a wet-cast concrete mix and exhibit a final handling weight in excess of 1,000 pounds (450 kg) per unit.

B. Scope of Work: The work shall consist of furnishing materials, labor, equipment and supervision for the construction of a precast modular block (PMB) retaining wall structure in accordance with the requirements of this section and in acceptable conformity with the lines, grades, design and dimensions shown in the project site plans.

C. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 31, Division 32 and Division 33 also apply to this Section.

1.2 PRICE AND PAYMENT PROCEDURES

A. Allowances. No allowance shall be made in the price of the retaining wall for excavation beyond the limits required for retaining wall construction as shown on the project plans. The cost of excavation for the purposes of site access shall be the responsibility of the General Contractor. Removal of unsuitable soils and replacement with select fill shall be as directed and approved in writing by the Owner or Owner's representative and shall be paid under separate pay items.

1.3 REFERENCES

A. Where the specification and reference documents conflict, the Owner's designated representative will make the final determination of the applicable document.

B. Definitions:
1. Precast Modular Block (PMB) Unit – machine-placed, "wet cast" concrete modular block retaining wall facing unit.
2. Geotextile – a geosynthetic fabric manufactured for use as a separation and filtration medium between dissimilar soil materials.
3. Drainage Aggregate – clean, crushed stone placed within and immediately behind the precast modular block units to facilitate drainage and reduce compaction requirements immediately adjacent to and behind the precast modular block units.
4. Unit Core Fill – clean, crushed stone placed within the hollow vertical core of a precast modular block unit. Typically, the same material used for drainage aggregate as defined above.
5. Foundation Zone – soil zone immediately beneath the leveling pad.
6. Retained Zone – soil zone immediately behind the drainage aggregate and wall infill for wall sections designed as modular gravity structures.

7. Leveling Pad – hard, flat surface upon which the bottom course of precast modular blocks are placed. The leveling pad may be constructed with crushed stone or cast-in-place concrete. A leveling pad is not a structural footing.
8. Wall Infill – the fill material placed and compacted between the drainage aggregate and the excavated soil face in retaining wall sections designed as modular gravity structures.

C. Reference Standards
   1. Design
      a. AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014.
      b. Minimum Design Loads for Buildings and Other Structures – ASCE/SEI 7-10.
      c. c.International Building Code, 2012 Edition.
      d. Design Manual for Segmental Retaining Walls, National Concrete Masonry Association, 3rd Edition, 2010
   2. Precast Modular Block Units
      a. ASTM C94 – Standard Specification for Ready-Mixed Concrete.
      b. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
      c. ASTM C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete.
      d. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
      e. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete.
      f. ASTM C666 – Standard Test Method for Concrete Resistance to Rapid Freezing and Thawing.
      g. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
      h. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete.
      i. ASTM C1611 – Standard Test Method for Slump Flow of Self-Consolidating Concrete.
      j. ASTM C1776 – Standard Specification for Wet-Cast Precast Modular Retaining Wall Units.
      k. ASTM D6916 – Standard Test Method for Determining Shear Strength Between Segmental Concrete Units (Modular Concrete Blocks).
   3. Geosynthetics
      a. AASHTO M 288 – Geotextile Specification for Highway Applications.
      b. ASTM D3786 – Standard Test Method for Bursting Strength of Textile Fabrics Diaphragm Bursting Strength Tester Method.
      c. ASTM D4354 – Standard Practice for Sampling of Geosynthetics for Testing.
      d. ASTM D4355 – Standard Test Method for Deterioration of Geotextiles
      e. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
      f. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
      g. ASTM D4595 – Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
      h. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
      i. ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile.
      j. ASTM D4759 – Standard Practice for Determining Specification Conformance of Geosynthetics.
      k. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
      l. ASTM D4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
      m. ASTM D6241 – Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
   4. Soils

a. AASHTO M 145 – AASHTO Soil Classification System.
b. AASHTO T 104 – Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
c. AASHTO T 267 – Standard Method of Test for Determination of Organic Content in Soils by Loss of Ignition.
d. ASTM C33 – Standard Specification for Concrete Aggregates.
e. ASTM D422 – Standard Test Method for Particle-Size Analysis of Soils.
f. ASTM D448 – Standard Classification for Sizes of Aggregates for Road and Bridge Construction.
g. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort. (12,400 ft-lbf/ft (2,700 kN-m/m)).
h. ASTM D1241 – Standard Specification for Materials for Soil-Aggregate Subbase, Base and Surface Courses.
i. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
j. ASTM D1557 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort. (56,000 ft-lbf/ft (2,700 kN-m/m)).
k. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
l. ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
m. ASTM D3080 – Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions.
n. ASTM D4254 – Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
o. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
p. ASTM D4767- Test Method for Consolidated-Undrained Triaxial Compression Test for Cohesive Soils.
q. ASTM D4972 – Standard Test Method for pH of Soils.
r. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Aggregate by Nuclear Methods (Shallow Depth).
s. ASTM G51 – Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing.
t. ASTM G57 – Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method.

5. Drainage Pipe
   a. ASTM D3034 – Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   b. ASTM F2648 – Standard Specification for 2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preconstruction Meeting. As directed by the Owner, the General Contractor shall schedule a preconstruction meeting at the project site prior to commencement of retaining wall construction. Participation in the preconstruction meeting shall be required of the General Contractor, Retaining Wall Design Engineer, Retaining Wall Installation Contractor, Grading Contractor and Inspection Engineer. The General Contractor shall provide notification to all parties at least 10 calendar days prior to the meeting.

1. Preconstruction Meeting Agenda:
   a. The Retaining Wall Design Engineer shall explain all aspects of the retaining wall construction drawings.
   b. The Retaining Wall Design Engineer shall explain the required bearing capacity of soil below the retaining wall structure and the shear strength of in-situ soils assumed in the retaining wall design to the Inspection Engineer.
   c. The Retaining Wall Design Engineer shall explain the required shear strength of fill soil in the retained and foundation zones of the retaining wall to the Inspection Engineer.
   d. The Retaining Wall Design Engineer shall explain any measures required for coordination of the installation of utilities or other obstructions in the retained fill zones of the retaining wall.
   e. The Retaining Wall Installation Contractor shall explain all excavation needs, site access and material staging area requirements to the General Contractor and Grading Contractor.

1.5 SUBMITTALS

A. Product Data. At least 14 days prior to construction, the General Contractor shall submit a minimum of six (6) copies of the retaining wall product submittal package to the Owner's Representative for review and approval. The submittal package shall include technical specifications and product data from the manufacturer for the following:
   1. Precast Modular Block System brochure
   2. Precast Modular Block concrete test results specified in paragraph 2.01, subparagraph B of this section as follows:
      a. 28-day compressive strength
      b. Air content
      c. Slump or Slump Flow (as applicable)
   3. Drainage Pipe
   4. Geotextile

B. Installer Qualification Data. At least 14 days prior to construction, the General Contractor shall submit the qualifications of the business entity responsible for installation of the retaining wall, the Retaining Wall Installation Contractor, per paragraph 1.07, subparagraph A of this section.

C. Retaining Wall Design Calculations and Construction Shop Drawings. At least 14 days prior to construction, the General Contractor shall furnish six (6) sets of construction shop drawings and six (6) copies of the supporting structural calculations report to the Owner for review and approval. This submittal shall include the following:
   1. Signed, sealed and dated drawings and engineering calculations prepared in accordance with these specifications.
   2. Qualifications Statement of Experience of the Retaining Wall Design Engineer as specified in paragraph 1.07, subparagraph B of this section.
   3. Certificate of Insurance of the Retaining Wall Design Engineer as specified in paragraph 1.06, subparagraph B of this section.

1.6 CONSTRUCTION SHOP DRAWING PREPARATION

A. The Retaining Wall Design Engineer shall coordinate the retaining wall construction shop drawing preparation with the project Civil Engineer, project Geotechnical Engineer and Owner's Representatives.

The General Contractor shall furnish the Retaining Wall Design Engineer the following project information required to prepare the construction shop drawings. This information shall include, but is not limited to, the following:

1. Current versions of the site, grading, drainage, utility, erosion control, landscape, and irrigation plans;
2. electronic CAD file of the civil site plans listed in (1);
3. report of geotechnical investigation and all addenda and supplemental reports;
4. recommendations of the project Geotechnical Engineer regarding effective stress shear strength and total stress shear strength (when applicable) parameters for in-situ soils in the vicinity of the proposed retaining wall(s) and for any fill soil that may potentially be used as backfill in retained and/or foundation zones of the retaining wall.

B. The Retaining Wall Design Engineer shall provide the Owner with a certificate of professional liability insurance verifying the minimum coverage limits of $1 million per claim and $1 million aggregate.

C. Design of the precast modular block retaining wall shall satisfy the requirements of this section. Where local design or building code requirements exceed these specifications, the local requirements shall also be satisfied.

D. The Retaining Wall Design Engineer shall note any exceptions to the requirements of this section by listing them at the bottom right corner of the first page of the construction shop drawings.

E. Approval or rejection of the exceptions taken by the Retaining Wall Engineer will be made in writing as directed by the Owner.

F. The precast modular block design, except as noted herein, shall be based upon:
1. AASHTO Load and Resistance Factor Design (LRFD) methodology as referenced in paragraph 1.03, subparagraph C.1., or
2. NCMA, Design of Segmental Retaining Walls, referenced in Section 1.03.C.1

G. In the event that a conflict is discovered between these specifications and a reasonable interpretation of the design specifications and methods referenced in paragraph F above, these specifications shall prevail. If a reasonable interpretation is not possible, the conflict shall be resolved per the requirements in paragraph 1.03, subparagraph A of this section.

H. Soil Shear Parameters. The Retaining Wall Design Engineer shall prepare the construction shop drawings based upon soil shear strength parameters from the available project data and the recommendations of the project Geotechnical Engineer. If insufficient data exists to develop the retaining wall design, the Retaining Wall Design Engineer shall communicate the specific deficiency of the project information or data to the Owner in writing.

I. Allowable bearing pressure requirements for each retaining wall shall be clearly shown on the construction drawings.

J. Global Stability. Overall (global) stability shall be evaluated in accordance with the principals of limit equilibrium analysis as set forth approved standards as referenced in paragraph 1.03, subparagraph C.1. The minimum factors of safety shall be as follows:

Normal Service (Static)	1.4
Seismic	1.1
Rapid Drawdown (if applicable)	1.2

K. Seismic Stability. Seismic loading shall be evaluated in accordance with AASHTO Load and Resistance Factor Design (LRFD) methodology as referenced in paragraph 1.03, subparagraph C.1.

1.7 QUALITY ASSURANCE

A. Retaining Wall Installation Contractor Qualifications. In order to demonstrate basic competence in the construction of precast modular block walls, the Retaining Wall Installation Contractor shall document compliance with the following:
   1. Experience.
      a. Construction experience with a minimum of 30,000 square feet (2,800 square meters) of the proposed precast modular block retaining wall system.
      b. Construction of at least ten (10) precast modular block (large block) retaining wall structures within the past three (3) years.
      c. Construction of at least 50,000 square feet (4,650 square meters) of precast modular block (large block) retaining walls within the past three (3) years.
   2. Retaining Wall Installation Contractor experience documentation for each qualifying project shall include:
      a. Project name and location
      b. Date (month and year) of construction completion
      c. Contact information of Owner or General Contractor
      d. Type (trade name) of precast modular block system built
      e. Maximum height of the wall constructed
      f. Face area of the wall constructed
   3. In lieu of the requirements set forth in items 1 and 2 above, the Retaining Wall Installation Contractor must be a certified Precast Modular Block Retaining Wall Installation Contractor as demonstrated by satisfactory completion of a certified precast modular block retaining wall installation training program administered by the precast modular block manufacturer.

B. Retaining Wall Design Engineer Qualifications and Statement of Experience. The Retaining Wall Design Engineer shall submit a written statement affirming that he or she has the following minimum qualifications and experience.
   1. The Retaining Wall Design Engineer shall be licensed to practice in the jurisdiction of the project location.
   2. The Retaining Wall Design Engineer shall be independently capable of performing all internal and external stability analyses, including those for seismic loading, compound stability, rapid draw-down and deep-seated, global modes of failure.
   3. The Retaining Wall Design Engineer shall affirm in writing that he or she has personally supervised the design of the retaining walls for the project, that the design considers all the requirements listed in paragraph 1.06 and that he or she accepts responsibility as the design engineer of record for the retaining walls constructed on the project.
   4. The Retaining Wall Design Engineer shall affirm in writing that he or she has personally designed in excess of 100,000 face square feet (9,000 face square meters) of modular block earth retaining walls within the previous three (3) years.
   5. In lieu of these specific requirements, the engineer may submit alternate documentation demonstrating competency in Precast Modular Block retaining wall design.

C. The Owner reserves the right to reject the design services of any engineer or engineering firm who, in the sole opinion of the Owner, does not possess the requisite experience or qualifications.

1.8 QUALITY CONTROL

A. The Owner's Representative shall review all submittals for materials, design, Retaining Wall Design Engineer qualifications and the Retaining Wall Installation Contractor qualifications.

B. The Owner's Representative shall retain the services of an Inspection Engineer who is experienced with the construction of precast modular block retaining wall structures to perform inspection and testing. The cost of inspection shall be the responsibility of the Owner. Inspection shall be continuous throughout the construction of the retaining walls.

C. The Inspection Engineer shall perform the following duties:
   1. Inspect the construction of the precast modular block structure for conformance with construction shop drawings and the requirements of this specification.
   2. Verify that soil or aggregate fill placed and compacted in the retained and foundation zones of the retaining wall conforms with paragraphs 2.04 and 2.05 of this section and exhibits the shear strength parameters specified by the Retaining Wall Design Engineer.
   3. Verify that the shear strength of the in-situ soil assumed by the Retaining Wall Design Engineer is appropriate.
   4. Inspect and document soil compaction in accordance with these specifications:
      a. Required dry unit weight
      b. Actual dry unit weight
      c. Allowable moisture content
      d. Actual moisture content
      e. Pass/fail assessment
      f. Test location – wall station number
      g. Test elevation
      h. Distance of test location behind the wall face
   5. Verify that all excavated slopes in the vicinity of the retaining wall are bench-cut as directed by the project Geotechnical Engineer.
   6. Notify the Retaining Wall Installation Contractor of any deficiencies in the retaining wall construction and provide the Retaining Wall Installation Contractor a reasonable opportunity to correct the deficiency.
   7. Notify the General Contractor, Owner and Retaining Wall Design Engineer of any construction deficiencies that have not been corrected timely.
   8. Document all inspection results.
   9. Test compacted density and moisture content of the retained backfill with the following frequency:
      a. At least once every 1,000 square feet (90 square meters) (in plan) per 9-inch (230 mm) vertical lift, and
      b. At least once per every 18 inches (460 mm) of vertical wall construction.

D. The Owner's engagement of the Inspection Engineer does not relieve the Retaining Wall Installation Contractor of responsibility to construct the proposed retaining wall in accordance with the approved construction shop drawings and these specifications.

E. The Retaining Wall Installation Contractor shall inspect the on-site grades and excavations prior to construction and notify the Retaining Wall Design Engineer and General Contractor if on-site conditions differ from the elevations and grading conditions depicted in the retaining wall construction shop drawings.

1.9 DELIVERY, STORAGE AND HANDLING

A. The Retaining Wall Installation Contractor shall inspect the materials upon delivery to ensure that the proper type, grade and color of materials have been delivered.

B. The Retaining Wall Installation Contractor shall store and handle all materials in accordance with the manufacturer's recommendations as specified herein and in a manner that prevents deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, UV exposure or other causes. Damaged materials shall not be incorporated into the work.

C. Geosynthetics
1. All geosynthetic materials shall be handled in accordance with ASTM D4873. The materials should be stored off the ground and protected from precipitation, sunlight, dirt and physical damage.

D. Precast Modular Blocks
1. Precast modular blocks shall be stored in an area with positive drainage away from the blocks. Be careful to protect the block from mud and excessive chipping and breakage. Precast modular blocks shall not be stacked more than three (3) units high in the storage area.

E. Drainage Aggregate and Backfill Stockpiles
1. Drainage aggregate or backfill material shall not be piled over unstable slopes or areas of the project site with buried utilities.
2. Drainage aggregate material shall not be staged where it may become mixed with or contaminated by poor draining fine-grained soils such as clay or silt.

PART 2 - MATERIALS

2.1 PRECAST MODULAR BLOCK RETAINING WALL UNITS

A. All units shall be wet-cast precast modular retaining wall units conforming to ASTM C1776.

B. All units for the project shall be obtained from the same manufacturer. The manufacturer shall be licensed and authorized to produce the retaining wall units by the precast modular block system patent holder/licensor and shall document compliance with the published quality control standards of the proprietary precast modular block system licensor for the previous three (3) years, or the total time the manufacturer has been licensed, whichever is less.

C. Concrete used in the production of the precast modular block units shall be first-purpose, fresh concrete. It shall not consist of returned, reconstituted, surplus or waste concrete. It shall be an original production mix meeting the requirements of ASTM C94 and exhibit the following:
1. Minimum 28-day compressive strength of 4,000 psi (27.6 MPa).
2. Shall be free of water soluble chlorides and chloride based accelerator admixtures.
3. 6% +/- 1½% air-entrainment in conformance ASTM C94.
4. Maximum slump of 5 inches +/- 1½ inches (125 mm +/- 40 mm) per ASTM C143 for conventional concrete mix designs.
5. Slump Flow for Self-Consolidating Concrete (SCC) mix designs shall be between 18 inches and 32 inches (450 mm and 800 mm) as tested in accordance with ASTM C1611.

D. Each concrete block shall be cast in a single continuous pour without cold joints. With the exception of half-block units, corner units and other special application units, the precast modular block units shall conform to the nominal dimensions listed in the table below and be produced to the dimensional tolerances shown.

Block Type	Dimension	Nominal Value	Tolerance
28” (710 mm) Block	Height	18” (457 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	28” (710 mm)	+/- 1/2” (13 mm)
41” (1030 mm) Block	Height	18” (457 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	40-1/2” (1030 mm)	+/- 1/2” (13 mm)
60” (1520 mm) Block	Height	18” (457 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	60” (1520 mm)	+/- 1/2” (13 mm)

* Block tolerance measurements shall exclude variable face texture

E. Individual block units shall have a nominal height of 18 inches (457 mm).

F. With the exception of half-block units, corner units and other special application units, the precast modular block units shall have two (2), circular dome shear knobs that are 10 inches (254 mm), 7.5 inches (190 mm), or 6.75 inches (171 mm) in diameter and 4 inches (102 mm) or 2 inches (51 mm) in height. The shear knobs shall fully index into a continuous semi-cylindrical shear channel in the bottom of the block course above. The peak interlock shear between any two (2) vertically stacked precast modular block units, with 10 inch (254 mm) diameter shear knobs, measured in accordance with ASTM D6916 shall exceed 6,500 lb/ft (95 kN/m) at a minimum normal load of 500 lb/ft (7kN/m). as well as an ultimate peak interface shear capacity in excess of 11,000 lb/ft (160 kN/m). The peak interlock shear between any two (2) vertically stacked precast modular block units, with 7.5 inch (190 mm) or 6.75 inch (171 mm) diameter shear knobs, measured in accordance with ASTM D6916 shall exceed 1,850 lb/ft (27 kN/m) at a minimum normal load of 500 lb/ft (7kN/m) as well as an ultimate peak interface shear capacity in excess of 10,000 lb/ft (146 kN/m).Test specimen blocks tested under ASTM D6916 shall be actual, full-scale production blocks of known compressive strength. The interface shear capacity reported shall be corrected for a 4,000 psi (27.6 MPa) concrete compressive strength. Regardless of precast modular block configuration, interface shear testing shall be completed without the inclusion of unit core infill aggregate.

G. The 28” (710 mm) and 41” (1030 mm) precast modular block units may be cast with a 13” (330 mm) wide, continuous vertical core slot completely through the block, or solid concrete.

H. Without field cutting or special modification, the precast modular block units shall be capable of achieving a minimum radius of 14 ft 6 in (4.42 m).

I. The precast modular block units shall be manufactured with an integrally cast shear knobs that establishes a standard horizontal set-back for subsequent block courses. The precast modular block system shall be available in the four (4) standard horizontal set-back facing batter options listed below:

Horizontal Set-Back/Blk. Course	Max. Facing Batter
3/8” (10 mm)	1.2˚
1-5/8” (41 mm)	5.2˚
9-3/8” (238 mm)	27.5˚
16-5/8” (422 mm)	42.7˚

1. The precast modular block units shall be furnished with the required shear knobs that provide the facing batter required in the construction shop drawings.

J. The precast modular block unit face texture shall be selected by the owner from the available range of textures available from the precast modular block manufacturer. Each textured block facing unit shall be a minimum of 5.76 square feet (0.54 square meters) with a unique texture pattern that repeats with a maximum frequency of once in any 15 square feet (1.4 square meters) of wall face.

K. The block color shall be selected by the owner from the available range of colors available from the precast modular block manufacturer.

L. All precast modular block units shall be sound and free of cracks or other defects that would interfere with the proper installation of the unit, impair the strength or performance of the constructed wall. PMB units to be used in exposed wall construction shall not exhibit chips or cracks in the exposed face or faces of the unit that are not otherwise permitted. Chips smaller than 1.5" (38 mm) in its largest dimension and cracks not wider than 0.012" (0.3 mm) and not longer than 25% of the nominal height of the PMB unit shall be permitted. PMB units with bug holes in the exposed architectural face smaller than 0.75" (19 mm) in its largest dimension shall be permitted. Bug holes, water marks, and color variation on non-architectural faces are acceptable. PMB units that exhibit cracks that are continuous through any solid element of the PMB unit shall not be incorporated in the work regardless of the width or length of the crack.

M. Preapproved Manufacturers.

N. Manufacturers of Redi-Rock Retaining Wall Systems as licensed by Redi-Rock International, LLC, 05481 US 31 South, Charlevoix, MI 49720 USA; telephone (866) 222-8400; website www.redi-rock.com.

O. Substitutions. Technical information demonstrating conformance with the requirements of this specification for an alternative precast modular block retaining wall system must be submitted for preapproval at least 14 calendar days prior to the bid date. Acceptable alternative PMB retaining wall systems, otherwise found to be in conformance with this specification, shall be approved in writing by the owner 7 days prior to the bid date. The Owner's Representative reserves the right to provide no response to submissions made out of the time requirements of this section or to submissions of block retaining wall systems that are determined to be unacceptable to the owner.

P. Value Engineering Alternatives. The owner may evaluate and accept systems that meet the requirements of this specification after the bid date that provide a minimum cost savings of 20% to the Owner. Construction expediency will not be considered as a contributing portion of the cost savings total.

2.2 GEOTEXTILE

A. A. Nonwoven geotextile fabric shall be placed as indicated on the retaining wall construction shop drawings. Additionally, the nonwoven geotextile fabric shall be placed in the v-shaped joint between adjacent block units on the same course. The nonwoven geotextile fabric shall meet the requirements Class 3 construction survivability in accordance with AASHTO M 288.

B. Preapproved Nonwoven Geotextile Products
1. Mirafi 140N
2. Propex Geotex 451

3. Skaps GT-142
4. Thrace-Linq 140EX
5. Carthage Mills FX-40HS
6. Stratatex ST 142

2.3 DRAINAGE AGGREGATE AND WALL INFILL

A. Drainage aggregate (and wall infill for retaining walls designed as modular gravity structures) shall be a durable crushed stone conforming to No. 57 size per ASTM C33 with the following particle-size distribution requirements per ASTM D422:

U.S. Standard Sieve Size	% Passing
1-½" (38 mm)	100
1" (25 mm)	95-100
½" (13 mm)	25-60
No. 4 (4.76 mm)	0-10
No. 8 (2.38 mm)	0-5

2.4 LEVELING PAD

A. The precast modular block units shall be placed on a leveling pad constructed from crushed stone or unreinforced concrete. The leveling pad shall be constructed to the dimensions and limits shown on the retaining wall design drawings prepared by the Retaining Wall Design Engineer.

B. Crushed stone used for construction of a granular leveling pad shall meet the requirements of the drainage aggregate and wall infill in section 2.04 or a preapproved alternate material.

C. Concrete used for construction of an unreinforced concrete leveling pad shall satisfy the criteria for AASHTO Class B. The concrete should be cured a minimum of 12 hours prior to placement of the precast modular block wall retaining units and exhibit a minimum 28-day compressive strength of 2,500 psi (17.2 MPa).

2.5 DRAINAGE

A. Drainage Pipe
1. Drainage collection pipe shall be a 4" (100 mm) diameter, 3-hole perforated, HDPE pipe with a minimum pipe stiffness of 22 psi (152 kPa) per ASTM D2412.
2. The drainage pipe shall be manufactured in accordance with ASTM D1248 for HDPE pipe and fittings.

B. Preapproved Drainage Pipe Products
1. ADS 3000 Triple Wall pipe as manufactured by Advanced Drainage Systems.

PART 3 - EXECUTION

3.1 GENERAL

A. All work shall be performed in accordance with OSHA safety standards, state and local building codes and manufacturer's requirements.

B. The General Contractor is responsible for the location and protection of all existing underground utilities. Any new utilities proposed for installation in the vicinity of the retaining wall, shall be installed concurrent with retaining wall construction. The General Contractor shall coordinate the work of subcontractors affected by this requirement.

C. New utilities installed below the retaining wall shall be backfilled and compacted to a minimum of 98% maximum dry density per ASTM D698 standard proctor.

D. The General Contractor is responsible to ensure that safe excavations and embankments are maintained throughout the course of the project.

E. All work shall be inspected by the Inspection Engineer as directed by the Owner.

3.2 EXAMINATION

A. Prior to construction, the General Contractor, Grading Contractor, Retaining Wall Installation Contractor and Inspection Engineer shall examine the areas in which the retaining wall will be constructed to evaluate compliance with the requirements for installation tolerances, worker safety and any site conditions affecting performance of the completed structure. Installation shall proceed only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Fill Soil.
   1. The Inspection Engineer shall verify that retained backfill material placed within a horizontal distance of one (1.0) times the wall height behind the wall blocks satisfies the criteria of this section.
   2. The Inspection Engineer shall verify that any fill soil installed in the foundation and retained soil zones of the retaining wall satisfies the specification of the Retaining Wall Design Engineer as shown on the construction drawings.

B. Excavation.
   1. The Grading Contractor shall excavate to the lines and grades required for construction of the precast modular block retaining wall as shown on the construction drawings. The Grading Contractor shall minimize over-excavation. Excavation support, if required, shall be the responsibility of the Grading Contractor.
   2. Over-excavated soil shall be replaced with compacted fill in conformance with the specifications of the Retaining Wall Design Engineer and "Division 31, Section 31 20 00 – Earthmoving" of these project specifications.
   3. Embankment excavations shall be bench cut as directed by the project Geotechnical Engineer and inspected by the Inspection Engineer for compliance.

C. Foundation Preparation.
   1. Prior to construction of the precast modular block retaining wall, the leveling pad area and undercut zone (if applicable) shall be cleared and grubbed. All topsoil, brush, frozen soil and organic material shall be removed. Additional foundation soils found to be unsatisfactory

beyond the specified undercut limits shall be undercut and replaced with approved fill as directed by the project Geotechnical Engineer. The Inspection Engineer shall ensure that the undercut limits are consistent with the requirements of the project Geotechnical Engineer and that all soil fill material is properly compacted according project specifications. The Inspection Engineer shall document the volume of undercut and replacement.

2. Following excavation for the leveling pad and undercut zone (if applicable), the Inspection Engineer shall evaluate the in-situ soil in the foundation and retained soil zones.
    a. The Inspection Engineer shall verify that the shear strength of the in-situ soil assumed by the Retaining Wall Design Engineer is appropriate. The Inspection Engineer shall immediately stop work and notify the Owner if the in-situ shear strength is found to be inconsistent with the retaining wall design assumptions.
    b. The Inspection Engineer shall verify that the foundation soil exhibits sufficient ultimate bearing capacity to satisfy the requirements indicated on the retaining wall construction shop drawings per paragraph 1.06 I of this section.

D. Leveling Pad.
1. The leveling pad shall be constructed to provide a level, hard surface on which to place the first course of precast modular block units. The leveling pad shall be placed in the dimensions shown on the retaining wall construction drawings and extend to the limits indicated.
2. Crushed Stone Leveling Pad. Crushed stone shall be placed in uniform maximum lifts of 6” (150 mm). The crushed stone shall be compacted by a minimum of 3 passes of a vibratory compactor capable of exerting 2,000 lb (8.9 kN) of centrifugal force and to the satisfaction of the Inspection Engineer.
3. Unreinforced Concrete Leveling Pad. The concrete shall be placed in the same dimensions as those required for the crushed stone leveling pad. The Retaining Wall Installation Contractor shall erect proper forms as required to ensure the accurate placement of the concrete leveling pad according to the retaining wall construction drawings.

3.4 PRECAST MODULAR BLOCK WALL SYSTEM INSTALLATION

A. The precast modular block structure shall be constructed in accordance with the construction drawings, these specifications and the recommendations of the retaining wall system component manufacturers. Where conflicts exist between the manufacturer’s recommendations and these specifications, these specifications shall prevail.

B. Drainage components. Pipe, geotextile and drainage aggregate shall be installed as shown on the construction shop drawings.

C. Precast Modular Block Installation
1. The first course of block units shall be placed with the front face edges tightly abutted together on adjacent blocks, on the prepared leveling pad at the locations and elevations shown on the construction drawings. The Retaining Wall Installation Contractor shall take special care to ensure that the bottom course of block units are in full contact with the leveling pad, are set level and true and are properly aligned according to the locations shown on the construction drawings.
2. Backfill shall be placed in front of the bottom course of blocks prior to placement of subsequent block courses. Nonwoven geotextile fabric shall be placed in the V-shaped joints between adjacent blocks. Drainage aggregate shall be placed in the V-shaped joints between adjacent blocks, and extend to a minimum distance of 12” (300 mm) behind the block unit.

3. Drainage aggregate shall be placed in 9 inch maximum lifts and compacted by a minimum of three (3) passes of a vibratory plate compactor capable exerting a minimum of 2,000 lb (8.9 kN) of centrifugal force.
4. Unit core fill shall be placed in the precast modular block unit vertical core slot. The core fill shall completely fill the slot to the level of the top of the block unit. The top of the block unit shall be broom-cleaned prior to placement of subsequent block courses. No additional courses of precast modular blocks may be stacked before the unit core fill is installed in the blocks on the course below.
5. Base course blocks for gravity wall designs (without geosynthetic soil reinforcement) may be furnished without vertical core slots. If so, disregard item 4 above, for the base course blocks in this application.
6. Nonwoven geotextile fabric shall be placed between the drainage aggregate and the retained soil (gravity wall design) if required on the retaining wall construction drawings.
7. Subsequent courses of block units shall be installed with a running bond (half block horizontal course-to-course offset). With the exception of 90 degree corner units, the shear channel of the upper block shall be fully engaged with the shear knobs of the block course below. The upper block course shall be pushed forward to fully engage the interface shear key between the blocks and to ensure consistent face batter and wall alignment. Drainage aggregate, unit core fill, geotextile and properly compacted backfill shall be complete and in-place for each course of block units before the next course of blocks is stacked.
8. The elevation of retained soil fill shall not be less than 1 block course (18" (457 mm)) below the elevation of the retained backfill throughout the construction of the retaining wall.
9. If included as part of the precast modular block wall design, cap units shall be secured with an adhesive in accordance with the precast modular block manufacturer's recommendation.

D. Construction Tolerance. Allowable construction tolerance of the retaining wall shall be as follows:
1. Deviation from the design batter and horizontal alignment, when measured along a 10' (3 m) straight wall section, shall not exceed 3/4" (19 mm).
2. Deviation from the overall design batter shall not exceed 1/2" (13 mm) per 10' (3 m) of wall height.
3. The maximum allowable offset (horizontal bulge) of the face in any precast modular block joint shall be 1/2" (13 mm).
4. The base of the precast modular block wall excavation shall be within 2" (50 mm) of the staked elevations, unless otherwise approved by the Inspection Engineer.
5. Differential vertical settlement of the face shall not exceed 1' (300 mm) along any 200' (61 m) of wall length.
6. The maximum allowable vertical displacement of the face in any precast modular block joint shall be 1/2" (13 mm).
7. The wall face shall be placed within 2" (50 mm) of the horizontal location staked.

3.5 WALL INFILL AND BACKFILL PLACEMENT

A. Backfill material placed immediately behind the drainage aggregate shall be compacted as follows:
1. 98% of maximum dry density at ± 2% optimum moisture content per ASTM D698 standard proctor or 85% relative density per ASTM D4254.

B. Compactive effort within 3' (0.9 m) of the back of the precast modular blocks should be accomplished with walk-behind compactors. Compaction in this zone shall be within 95% of maximum dry density as measured in accordance with ASTM D698 standard proctor or 80% relative density per ASTM D 4254. Heavy equipment should not be operated within 3' (0.9 m) of the back of the precast modular blocks.

C. Backfill material shall be installed in lifts that do not exceed a compacted thickness of 9” (230 mm).

D. At the end of each work day, the Retaining Wall Installation Contractor shall grade the surface of the last lift of the granular wall infill to a 3% ± 1% slope away from the precast modular block wall face and compact it.

E. The General Contractor shall direct the Grading Contractor to protect the precast modular block wall structure against surface water runoff at all times through the use of berms, diversion ditches, silt fence, temporary drains and/or any other necessary measures to prevent soil staining of the wall face, scour of the retaining wall foundation or erosion of the reinforced backfill or wall infill.

3.6 OBSTRUCTIONS IN THE INFILL ZONE

A. The Retaining Wall Installation Contractor shall make all required allowances for obstructions behind and through the wall face in accordance with the approved construction shop drawings.

B. Should unplanned obstructions become apparent for which the approved construction shop drawings do not account, the affected portion of the wall shall not be constructed until the Retaining Wall Design Engineer can appropriately address the required procedures for construction of the wall section in question.

3.7 COMPLETION

A. For walls supporting unpaved areas, a minimum of 12” (300 mm) of compacted, low-permeability fill shall be placed over the granular wall infill zone of the precast modular block retaining wall structure. The adjacent retained soil shall be graded to prevent ponding of water behind the completed retaining wall.

B. For retaining walls with crest slopes of 5H:1V or steeper, silt fence shall be installed along the wall crest immediately following construction. The silt fence shall be located 3’ to 4’ (0.9 m to 1.2 m) behind the uppermost precast modular block unit. The crest slope above the wall shall be immediately seeded to establish vegetation. The General Contractor shall ensure that the seeded slope receives adequate irrigation and erosion protection to support germination and growth.

C. The General Contractor shall confirm that the as-built precast modular block wall geometries conform to the requirements of this section. The General Contractor shall notify the Owner of any deviations.

3.8 AS-BUILT

A. Final As-built of all items location and elevations prepared by a CT Licensed Land Surveyor in paper, Mylar and AutoCad format signed and sealed accuracy class A-2/T-2 for owner and engineer.

B. Final As-built of all items location and elevations .dwg file in AutoCAD Civil 3D format of as built prepared by a CT Licensed Land Surveyor with Civil 3D pipe networks.

END OF SECTION 32 32 15

SECTION 328400 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Specification Sections
   1. Division 22 – Plumbing
   2. Division 26 – Electrical
   3. Division 32 – Turf's and Grasses, Soil Preparation, Plantings

1.2 SUMMARY

A. Section Includes: All labor, materials, transportation, and services necessary to furnish and install Irrigation systems as shown on drawings and described herein including all testing and permits.
   1. Locate, purchase, deliver, and install piping, conduit, sleeves, 120 bolt and low voltage electrical and water connections, valves, backflow preventer devices, controllers, rain sensors, spray and bubbler heads, drip irrigation lines, and associated accessories for a fully operational irrigation system.
   2. Testing and startup of the irrigation system
   3. Prepare as-built record set of drawings
   4. Training of owner's maintenance personnel in operation requirements of system.

B. The system shall operate efficiently and evenly irrigate all areas intended and be complete in every respect and shall be left ready for operation to the satisfaction of the Owner's Representative/Architect.

C. Coordinate with other trades, as needed to complete work, including but not limited to Water Point of Connection (POC), Backflow Preventer Device (BFD), and electrical hookups.

1.3 DEFINITIONS

A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.

B. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.

C. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.

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. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation where the Owner's Representative accepts that all work in these sections is complete and

the Warranty period has begun. This date may be different that the date of substantial completion for the other sections of the project.

F. Final Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of specification. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation work run concurrently.

1.4 PERFORMANCE REQUIREMENTS

A. Irrigation zone control shall be automatic operation with controller and automatic control valves. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated. Irrigation piping and related equipment are drawn diagrammatically. Scaled dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions and immediately notify the Owner's Representative of discrepancies between the drawings or specifications and the actual conditions. Although sizes and locations of plants and or irrigation equipment are drawn to scale wherever possible, it is not within the scope of the drawings to show all necessary offsets, obstructions, or site conditions. The Contractor shall be responsible to install the work in such a manner that it will be in conformance to site conditions, complete, and in good working order.

B. Delegated Design: Design 100 percent coverage irrigation system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
   1. Irrigation Main Piping: 200 psig (1380 kPa).
   2. Circuit Piping: 150 psig (1035 kPa).

1.5 PERMITS AND REGULATIONS

A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.

B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.

C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner's Representative shall determine which shall govern.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Material list shall include the manufacturer, model number, and description of all materials and equipment to be used.

B. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For irrigation 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.

D. Record and As-built drawings:
1. As built plan shall be submitted for approval prior to the preparation of the controller chart.
2. Drawing shall include dimensions from two permanent points of reference i.e. building corners, road intersections, to the locate the following
   a. Pressure Irrigation Lines – Dimensioned at 100 foot intervals along routing
   b. Control wire routing
   c. Gate Valves
   d. Automatic Control Valves
   e. Quick Coupling Valves
   f. Connection to water supply

E. Controller/Zoning Chart:
1. Chart shall be a black line print which is a reduced scale of the actual record plan with zone coverages identified with different colors.
2. The plan shall be of a size applicable for mounting in the controller box and be laminated with 10 mil plastic.
3. The chart must be prepared and approved prior to final inspection of the irrigation system.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Irrigation systems, drawn to scale, on which components are shown and coordinated with each other, using input from Installers of the items involved. Also include adjustments necessary to avoid plantings and obstructions such as signs and light standards.

B. Qualification Data: For qualified Installer.

C. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.

D. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manuals and Guarantees: For sprinklers, controllers, and automatic control valves to include in operation and maintenance manuals.
1. Prepare and deliver to the Owner’s Representative within ten calendar days prior to completion of construction, two 3-ring hard cover binders containing the following information:
   a. Index sheet stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturers' representatives.

b. Catalog and parts sheets on all material and equipment.
c. Guarantee statement. The start of the guarantee period shall be the date the irrigation system is
d. accepted by the Owner.
e. Complete operating and maintenance instruction for all major equipment.
f. Irrigation product manufacturers warrantees.

2. In addition to the above-mentioned maintenance manuals, provide the Owner's maintenance personnel with instructions for maintaining major equipment and show evidence in writing to the Owner's Representative at the conclusion of the project that this has been rendered.

1.9 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. Impact, Spray Sprinklers, Bubblers, and Emitters,: Equal to 5 percent of amount installed for each type and size indicated, but no fewer than 5 units.

1.10 QUALITY ASSURANCE

A. It is the intention of this specification to accomplish the work of installing an automatic irrigation system, which will operate in an efficient and satisfactory manner. The irrigation system shall be installed and made operational according to the workmanlike standards established for landscape installation and sprinkler irrigation operation as set forth by the most recent Best Management Practices (BMP) of the Irrigation Association.

B. The specification can only indicate the intent of the work to be performed rather than a detailed description of the performance of the work. It shall be the responsibility of the Contractor to install said materials and equipment in such a manner that they shall operate efficiently and evenly and support optimum plant growth and health.

C. Installer Qualifications: The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the work.

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.

1.11 DELIVERY, STORAGE, AND HANDLING

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

B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.12 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of water service.
   2. Do not proceed with interruption of water service without Architect's and Construction Manager's written permission.

1.13 POINT OF CONNECTION

A. The point of connection of the irrigation system to its electrical power sources shall be provided by the General Contractor’s licensed electrical Contractor per governing codes at the location shown on the drawings. The irrigation Contractor will connect the power to provided junction box or grounded plug receptacle.

B. The point of connection of the irrigation system to its potable and or non-potable water sources, including the main shutoff valve and backflow preventer shall be provided by the General Contractor’s licensed plumbing Contractor per governing codes at the location shown on the drawings. The minimum size and water pressure of the pressurized line will be as noted on the irrigation drawing.

PART 2 - PRODUCTS

2.1 MATERIALS GENERAL

A. All materials shall be of standard, approved and first grade quality and shall be new and in perfect condition when installed and accepted.

B. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and configuration desired only. Other manufacturer's equipment may be submitted for approval with written approval by the Owner’s Representative. Substituted equipment shall not substantially alter the operations of the system.

C. Approval of any items or substitutions indicates only that the product(s) apparently meet the requirements of the drawings and specifications on the basis of the information or samples submitted. The Contractor shall be responsible for the performance of substituted items. If the substitution proves to be unsatisfactory or not compatible with other parts of the system, the Contractor shall replace said items with the originally specified items, including all necessary work and modifications to replace the items, at no cost to the owner.

2.2 PIPES, TUBES, AND FITTINGS

A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

B. PE Pipe with Controlled OD: ASTM F 771, PE 3408 compound, SDR 11.
   1. PE Butt, Heat-Fusion Fittings: ASTM D 3261.

2. PE Socket-Type Fittings: ASTM D 2683.

C. PE Pressure Pipe: AWWA C906, with DR of 7.3, 9, or 9.3 and PE compound number required to give pressure rating not less than 200 psig (1380 kPa).
1. PE Butt, Heat-Fusion Fittings: ASTM D 3261.
2. PE Socket-Type Fittings: ASTM D 2683.

D. PVC Pipe, Non-pressure: ASTM D 1785, PVC 1120 compound, Schedule 40 and 80.
1. PVC Socket Fittings: ASTM D 2467, Schedule 80.
2. PVC Threaded Fittings: ASTM D 2464, Schedule 80, PVC 1120 comound, Type 1 Cell Class 12454.
3. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.

E. PVC Pipe, Pressure Rated 3 NPS (DN 75) and larger: ASTM D 2241, PVC 1120 compound, SDR 21, Class 200 bell and gasket. Rubber Gaskets shall conform to ASTM D3139 and F477.
1. PVC Fittings: Class 200 conforming to SDR 21, gasketed Joints ASTM D3139 and F477 compliant.

F. Brass Pipe and Fittings
1. Where indicated on drawings, use red brass threaded pipe
2. Fittings shall be red brass conforming to Federal specification #WW-P-460

G. Galvanized Steel Pipe: ASTM A 53/ A53M, Standard Weight, Type E, Grade B
1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless-steel pipe with threaded ends.

H. Ductile Iron Fittings, Push On Joint: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
1. Gaskets: AWWA C111 Rubber

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

C. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Form: Sheet, Color Black, Material type LLDPE film of 0.008-inch (0.20-mm) minimum thickness or high-density, cross-laminated PE film of 0.004-inch (0.10-mm)

2.5 MANUAL VALVES

A. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following
   1. Conbraco Industries, Inc.: Apollo Valves
   2. Crane Co.: Crane Valve Group; Crane Valves
   3. Crane Co.: Crane Valve Group; Jenkins Valves
   4. Milwaulkee Valve Company
   5. Mueller Co.; Water Products Division
   6. NIBCO INC.
   7. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Shutoff Rods for Curb-Valve Casings: Furnish **two** steel, tee-handle shutoff rod(s) with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve for Project.

C. Brass Ball Valves: MSS SP-110, Two Piece full port, forged brass with PFTE seats.
   1. SWP Rating: 150 psig (1035 kPa).
   2. CWP Rating: 600 psig (4140 kPa).
   3. Ends: Threaded or solder joint if indicated.
   4. Ball: Chrome-plated brass.

D. Bronze Ball Valves: MSS SP-110, Two piece full port bronze with PFTE seats.
   1. SWP Rating: 150 psig (1035 kPa).
   2. CWP Rating: 600 psig (4140 kPa).
   3. Ends: Threaded or solder joint if indicated.
   4. Ball: Chrome-plated brass.

E. Plastic Ball Valves: MSS SP-122, PVC Union Type, full port.
   1. Pressure: 150 psig (1035 kPa)
   2. End Connections: Socket or threaded.

F. Bronze Gate Valves: MSS SP-80, Type 2, Class 125, ASTM B62 bronze with integral seat and screw in bonnet. Non rising stem, asbestos free with Malleable iron or bronze handwheel.
   1. CWP Rating: 200 psig (1380 kPa).
   2. Ends: Threaded or solder joint.
   3. Disc: Solid wedge; bronze.

G. Iron Gate Valves, Resilient Seated: AWWA C509, ductile or gray iron with bronze trim, mechanical joint or push-on joint.
   1. Pressure Rating: 200 psig (1380 kPa) minimum.
   2. Interior Coating: Comply with AWWA C550.
   3. Body Design: Nonrising stem.
   4. Operator: Stem nut.
   5. Disc: Solid wedge with resilient coating.

H. Iron Gate Valve Casings: AWWA M44 for cast-iron valve casings, adjustable top section extensions of length required for depth of burial of valve.
   1. Barrel: Approximately 5-inch (125-mm) diameter.
   2. Plug: With lettering "WATER."
   3. Bottom Section: With base of size to fit over valve.
   4. Base Support: Concrete collar.

I. Operating Wrenches for Iron Gate Valve Casings: Furnish two steel, tee-handle operating wrench(es) with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut for Project.

J. Iron Gate Valves, NRS: MSS SP-70 Type, I, ASTM A 126 gray iron body with bolted bonnet, and asbestos free packing and gasket
1. CWP Rating: 200 psig (1380 kPa).
2. Ends: Flanged.
3. Trim: All bronze.
4. Disc: Solid wedge.

2.6 PRESSURE-REDUCING VALVES

A. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following
1. Conbraco Industries, Inc.; Apollo Valves
2. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
3. Zurn Plumbing Products Group; Wilkins Water Control Products

B. Water Regulators: ASSE 1003, Bronze for NPS 2 (DN50) and smaller: Cast iron with interior lining complying with AWWA C550 or FDA Approved, for NPS 2-1/2 and NPS 3 (DN 65 and DN 80)
1. Pressure Rating: Initial pressure of 150 psig (1035 kPa).
2. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
3. Capacities and Characteristics:
a. Size: <**Insert NPS (DN)**>.
b. Design Flow Rate: <**Insert gpm (L/s)**>.
c. Design Inlet Pressure: <**Insert psig (kPa)**>.
d. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.

C. Water Control Valves: Pilot-operation, diaphragm-type, single-seated main water control valve. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
1. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
2. Pattern: [**Angle**] [**Globe**]-valve design.
3. Trim: Stainless steel.
4. Pressure Rating: Initial pressure of 150 psig (1035 kPa) minimum.
5. End Connections: Threaded for NPS 2 (DN 50) and smaller; **flanged** for NPS 2-1/2 (DN 65) and larger.
6. Capacities and Characteristics:
a. Size: <**Insert NPS (DN)**>.
b. Design Flow Rate: <**Insert gpm (L/s)**>.
c. Design Inlet Pressure: <**Insert psig (kPa)**>.
d. Design Outlet Pressure Setting: <**Insert psig (kPa)**>.

2.7 AUTOMATIC CONTROL VALVES

A. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following
1. Hunter Industries Incorporated

2. Rain Bird Corporation
3. Toro Company (The); Irrigation Division
4. Weathermatic.

B. Plastic Automatic Control Valves
1. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.

2.8 AUTOMATIC DRAIN VALVES

A. Description: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig (17 to 20 kPa).

2.9 TRANSITION FITTINGS

A. General Requirements: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following
1. Georg Fischer
2. Harvel Plastics
3. Spears Manufacturing Company
4. NIBCO Inc.

C. Transition Couplings: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include one brass or stainless-steel threaded end, one solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

2.10 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following
1. Georg Fischer Central Plastics, LLC
2. Hart Industries International, Inc.
3. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
4. Zurn Plumbing Products Group; Wilkins Water Control Products

C. Dielectric Unions: Factory-fabricated union, NPS 2 (DN 50) and smaller, Pressure rating 150 psig (1035 kPa) minimum at 180 deg F (82 deg C) with Solder-joint copper alloy and threaded ferrous end connections; threaded ferrous ends

D. Dielectric Flanges: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger. Pressure rating 150 psig (1035 kPa) minimum at 180 deg F (82 deg C) with solder-joint copper alloy and threaded ferrous end connections.

E. Dielectric-Flange Kits: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 (DN 65) and larger with pressure rating of 150 psig (1035 kPa) minimum
   a. Gasket: Neoprene or phenolic.
   b. Bolt Sleeves: Phenolic or polyethylene.
   c. Washers: Phenolic with steel backing washers.

F. Dielectric Couplings: Galvanized-steel coupling, pressure Rating of 300 psig (2070 kPa) at 225 deg F (107 deg C), female threaded end connections, and inert and noncorrosive propylene lining.

G. Dielectric Nipples: Electroplated steel nipple complying with ASTM F 1545, with pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C), male threaded or grooved end connections and inert and noncorrosive propylene lining.

2.11 PVC PRESSURE PIPE JOINT RESTRAINT

A. PVC Joint Restraint: Pipe to Pipe Restraints shall meet the requirements of UNI-B-13-94.
   1. Restraint Material: Ductile iron conforming to ASTM A536, Grade 65-45-12 or ASTM A36 Steel.
   2. Restrain Device Coating: Manufacturers standard corrosion resistant product.
   3. A split, non-serrated ring shall be utilized on the fitting bell.
   4. A split, serrated ring shall be used to grip the pipe, and a sufficient number of bolts shall be used to connect the bell ring to the gripping ring
   5. Restraint rods, bolts and nuts Material: Low Alloy Steel conforming to AWWA/ANSI C111/A21.11.

B. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following
   1. EBAA Iron INC.
   2. Ford Meter Box Company, Inc.
   3. Harco Fittings, The Harrington Corporation

2.12 MISCELLANEOUS PIPING SPECIALITIES

A. Water Hammer Arresters: ASSE 1010 or PDI WH 201, with bellows or piston-type pressurized cushioning chamber and in sizes complying with PDI WH 201, Sizes A to F.

B. Pressure Gages: ASME B40.1. Include 4-1/2-inch- (115-mm-) diameter dial, dial range of two times system operating pressure, and bottom outlet.

2.13 BACKFLOW PREVENTION DEVICES

A. Reduced-Pressure-Zone (RPZ) Backflow Preventers:
   1. Available Manufacturers:
      a. Ames Co.
      b. Apollo Valves - Apollo Valves - Conbraco Industries, Inc.
      c. Watts Industries, Inc.; Water Products Div.
      d. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 10 psig maximum, through middle 1/3 of flow range.
5. Sizes: ¾" thru 10"
6. Body: Brass or bronze for 2" and smaller; cast iron or steel with interior lining complying with AWWA C550 or that is FDA approved for 2 ½" and larger.
7. Configuration: Comply with drawing requirements.
8. Accessories:
   a. Ball type with threaded ends on inlet and outlet of 2" and smaller;
   b. Gate Valves type, outside screw and yoke gate-type with flanged ends on inlet and outlet of 2 ½" and larger.
   c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
9. The backflow prevention device shall be certified to NSF/ANSI 372 shall be ASSE Listed 1013, rated to 80 degree F, and supplied with full port ball valves.
10. The main body and access covers shall be low lead bronze (ASTM B 584)
11. The seat ring and all internal polymers shall be NSF Listed Noryl and the seat disc elastomers shall be silicone.
12. Backflow Preventer shall be as indicated on the drawings.

2.14 ELECTRICAL CONTROL WIRING

A. Low voltage
   1. The electrical control wire shall be direct burial type UF, no. 14 AWG, solid, single conductor, copper wire UL approved or larger, if required to operate system as designed.
   2. For 2-Wire controllers all irrigation wire for the controller, flow sensor, master valve, hydrometer, remote control valves and moisture sensors shall be per the controller manufacturer's specifications and recommendations.
   3. Color code wires to each valve. Common wire shall be white.
   4. If multiple controllers are being utilized, and wire paths of different controllers cross each other, both common and control wires from each controller to be of different colors.
   5. Control wire splices: Splices are when required shall be placed in splice boxes.
   6. Wire connections shall be per the controller manufacturer's specifications and recommendations.
   7. Electrical Dry Connection. Spears DS -400, pre-drilled dri-splice connector with crimp sleeves; or DRYCONN #10222 waterproof connectors by King Innovations (#22 to #12 AWG).

B. High voltage
   1. Shall be of type as required by local codes and ordinances.
   2. Shall be of proper size to accommodate needs of equipment it is to serve.

2.15 SPRINKLERS

A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.

B. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following
   1. Hunter Industries Incorporated
   2. K-RAIN Manufacturing Corporation
   3. Rain Bird Corporation

C. Plastic, Pop-up, Gear-Drive Rotary Sprinklers:

1. Capacities and Characteristics: As indicated for sprinklers indicated on drawings. At minimum The sprinkler shall be of the gear-driven, rotary type, capable of covering a variable radius at 45 PSI with a variable discharge rate. The sprinkler shall be available with standard nozzles to control discharging rates.
2. The sprinkler shall be both full-circle and adjustable part-circle operation in a single unit. The sprinkler shall be minutely adjustable from 50° to 360°. It shall be adjustable in all phases of installation. The sprinkler shall be equipped with a self-adjusting stator to ensure constant rotation speed regardless of nozzle installed.
3. The sprinkler shall be equipped with a drain check valve to prevent low head drainage, and be capable of checking up to 10 feet (3.0 meters) in elevation change.
4. The sprinkler shall have radius adjustment capabilities by means of a stainless-steel nozzle retainer/radius adjustment screw.
5. The sprinkler shall have a non-strippable drive mechanism that allows the nozzle turret to be turned during operation, without damage. It shall also have an automatic arc return feature that returns the nozzle turret to its proper orientation if it is turned outside its intended arc of coverage.
6. The sprinkler shall be available with the following options as an above ground shrub head, a 3-1/2 inch pop-up, a 4-inch pop-up, a 6-inch (15cm) pop-up , or as a 12-inch pop-up.
7. The unit shall have a 3/4-inch or 1 inch Female National Pipe Thread (FNPT) inlet based on designation.
8. The sprinkler shall be serviceable after installation in the field by unscrewing the body cap, removing the riser assembly, and extracting the inlet filter screen.
9. The body and riser of the sprinkler shall be constructed of corrosion resistant, impact resistant, heavy-duty A.B.S. It shall have a stainless-steel spring for positive retraction of the riser when irrigation is complete. When specified, the riser and nozzle-turret assembly shall be encased in stainless steel. The sprinkler shall carry a five-year, exchange warranty (not prorated).

D. Plastic, Pop-up Spray Sprinklers:

1. Capacities and Characteristics: As indicated for sprinklers indicated on drawings. The sprinkler shall be capable of covering a variable) radius at 45 PSI, with a variable full circle discharge rate.
2. The sprinkler shall be available with a 4-, 6-, or 12-inch (10-, 15-, or 30-cm) pop-up stroke, depending on the body specified, to bring the nozzle into a clean environment. The sprinkler shall have the option of either a factory-installed or field-installed drain check valve capable of checking up to 14 feet (4.3 m) in elevation change
3. The sprinkler shall have a standard pressure-regulating device as an integral part of the pop-up riser. This regulator will provide optimal distribution uniformity of the MP Rotator by maintaining a constant outlet pressure of 40 PSI with inlet pressures of up to 100 PSI, regardless of the rotator installed.
4. The body of the sprinkler shall be constructed of corrosion and UV-resistant, heavy-duty A.B.S. The riser of the sprinkler shall be constructed of abrasion and UV-resistant A.B.S. and shall be adjustable for pattern alignment. The riser shall be compatible with female threaded nozzles and shall have a stainless-steel spring for positive retraction when irrigation is complete.
5. The sprinkler shall have a factory-installed, removable flush cap with a pull-up tab that shall prevent debris from entering the sprinkler during installation and allow the system to be flushed before installing the nozzle. The flush cap shall have a directional flushing action that allows the water to escape only in one direction. The flush cap shall open as the stem extends and completely close when the stem is in the retracted position.
6. The sprinkler shall have an exposed surface diameter after installation of 2-1/4 inches (6 cm). The sprinkler shall have a 1/2-inch Female National Pipe Thread (FNPT) bottom inlet.

2.16 QUICK COUPLERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following
   1. Hunter Industries Incorporated
   2. Rain Bird Corporation

B. Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.
   1. Locking-Top Option: Vandal-resistant locking feature. Include two matching key(s).

2.17 CONTROLLERS

A. Description:

   1. Controller Stations for Automatic Control Valves: Each station is variable from approximately **5 to 60** minutes. Include switch for manual or automatic operation of each station.

   2. Interior Control Enclosures: NEMA 250, Type 12, dripproof, with locking cover and four matching keys.
      a. Body Material: Molded plastic.
      b. Mounting: Surface type for wall.

   3. Control Transformer: 24-V secondary, with primary fuse.
   4. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.
      a. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation.
      b. Nickel-Cadmium Battery and Trickle Charger: Automatically powers timing device during power outages.
      c. Surge Protection: Metal-oxide-varistor type on each station and primary power.
   5. Moisture Sensor: Adjustable from one to seven days, to shut off water flow during rain.
   6. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.
      a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.
      b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.
      c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

2.18 BOXES FOR AUTOMATIC CONTROL VALVES

A. Manufacturers: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following
   1. Carson Industries, LLC
   2. NDS
   3. Oldcastle, Inc.

B. Plastic Boxes:
   1. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade. Boxes shall be green in color with rigid base and sides, supplied with bolt lock cover secured with stainless steel bolts.
   2. Shape:
      a. Round – Quick connection
      b. Rectangular – Control valves, isolation valves, shutoffs.
   3. Size – As required for valves and service with available height extension sections
   4. Material: HDPE Injection molded
   5. Lettering: "ICV"

C. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/4 inch (19 mm) minimum to 1-1/2 inches (37.5 mm) maximum.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

B. Install warning tape directly above pressure piping, 12 inches (300 mm) below finished grades, except 6 inches (150 mm) below subgrade under pavement and slabs.

C. Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from 3/4 to 1-1/2 inches (19 to 37.5 mm), to depths indicated below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.

D. Provide minimum cover over top of underground piping according to the following:

   1. Irrigation Main Piping: Minimum depth of 18 inches (450 mm) below finished grade, except below pavements and vehicle access areas.
   2. Circuit Piping: 18 inches (450 mm).
   3. Drain Piping: 24 inches (600 mm).
   4. Sleeves: 36 inches (900 mm).

3.2 PREPARATION

A. Set stakes to identify locations of proposed irrigation system. Obtain Architect's approval before excavation.

3.3 PIPING INSTALLATION

A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.

B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.

C. Install piping free of sags and bends.

D. Install groups of pipes parallel to each other, spaced to permit valve servicing.

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

F. Install unions adjacent to valves and to final connections to other components with NPS 2 (DN 50) or smaller pipe connection.

G. Install flanges adjacent to valves and to final connections to other components with NPS 2-1/2 (DN 65) or larger pipe connection.

H. Install underground thermoplastic piping according to ASTM D 2774 and ASTM F 690, and ASTM F1668.

I. Install expansion loops in control-valve boxes for plastic piping.

J. Lay piping on solid subbase, uniformly sloped without humps or depressions.

K. Install ductile-iron piping according to AWWA C600.

L. Install PVC piping in dry weather when temperature is above 40 deg F (5 deg C). Allow joints to cure at least 24 hours at temperatures above 40 deg F (5 deg C) before testing.

M. Install water regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet. Install aboveground or in control-valve boxes.

N. Water Hammer Arresters: Install between connection to building main and circuit valves aboveground or in control-valve boxes.

O. Install piping in sleeves under parking lots, roadways, and sidewalks.

P. Install sleeves made of Schedule 40 PVC pipe and socket fittings, and solvent-cemented joints.

Q. Install transition fittings for plastic-to-metal pipe connections according to the following:

1. Underground Piping:
   a. NPS 1-1/2 (DN 40) and Smaller: Plastic-to-metal transition fittings.
   b. NPS 2 (DN 50) and Larger: AWWA transition couplings.

2. Aboveground Piping:
   a. NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings.
   b. NPS 2 (DN 50) and Larger: Use dielectric flange kits with one plastic flange.

R. Install dielectric fittings for dissimilar-metal pipe connections according to the following:

1. Underground Piping:
   a. NPS 2 (DN 50) and Smaller: Dielectric coupling or dielectric nipple.
   b. NPS 2-1/2 (DN 65) and Larger: Prohibited except in control-valve box.

2. Aboveground Piping:
   a. NPS 2 (DN 50) and Smaller: Dielectric union.
   b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric flange.
   c. NPS 5 (DN 125) and Larger: Dielectric flange kit.

3. Piping in Control-Valve Boxes:
   a. NPS 2 (DN 50) and Smaller: Dielectric union.
   b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric flange.
   c. NPS 5 (DN 125) and Larger: Dielectric flange kit.

3.4 IRRIGATION MAIN PIPING JOINT RESTRAINT

A. Install per manufacturer directions at locations indicated on plans and where required for utility conflict pipe routing.

3.5 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

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

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Flanged Joints: Select rubber gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

E. Ductile-Iron Piping Gasketed Joints: Comply with AWWA C600 and AWWA M41.

F. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End PE Pipe and Fittings: Use butt fusion.
   2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

G. PVC Piping Solvent-Cemented 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 Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   3. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.6 VALVE INSTALLATION

A. General
   1. Set valves perpendicular to finished grades, except as otherwise indicated.
   2. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the access box.

3. Seal threaded connections on pressure side of control valves with Teflon tape or approved plastic joint type compound.
4. Provide poured concrete thrust blocks where required.

B. Underground Iron Gate Valves, Resilient Seat: Comply with AWWA C600 and AWWA M44. Install in valve casing with top flush with grade.
1. Install valves and PVC pipe with restrained, gasketed joints.

C. Aboveground Valves: Install as components of connected piping system.

D. Pressure-Reducing Valves: Install aboveground between shutoff valves. Install full-size valved bypass.

E. Throttling Valves: Install in underground piping in boxes for automatic control valves.

F. Drain Valves: Install in underground piping in boxes for automatic control valves.

3.7 SPRINKLER INSTALLATION

A. Install sprinklers after hydrostatic test is completed.

B. Install sprinklers at manufacturer's recommended heights.

C. Locate part-circle sprinklers to maintain a minimum distance of 4 inches (100 mm) from walls and 2 inches (50 mm) from other boundaries unless otherwise indicated.

3.8 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

A. Equipment Mounting: Install interior controllers on wall.
1. Place and secure anchorage devices. Use 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.

B. Install control cable in same trench as irrigation piping and at least 2 inches (51 mm) below or beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.

C. Control Wiring:
1. Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines wherever possible.
2. Where more than one wire is placed in a trench, the wiring shall be taped together at intervals of ten feet.
3. An expansion curl shall be provided within three feet of each wire connection. Expansion curl at electric control valves shall be of sufficient length so that in case of repair, the valve bonnet may be brought to the surface without disconnecting the control wires. Control wires shall be laid loosely in trench without stress or stretching of control wire conductors.
4. Connect each control valve to one station of a controller except as otherwise indicated.
5. Connect remote control valves to common ground wire system.
6. Make wire connections to remote control electric valves and splices of wire in the field, using wire connectors and sealing cement, in accordance with manufacturer's recommendations.
7. Provide tight joints to prevent leakage of water and corrosion build-up on the joint.

8. All splices shall be made with Spears DS-400, Dryconn 10222, or equal. Use one splice per connector sealing pack.

3.9 CONNECTIONS

A. Comply with requirements for piping specified in Section 221113 "Facility Water Distribution Piping" for water supply from exterior water service piping, water meters, protective enclosures, and backflow preventers. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.

C. Connect wiring between controllers and automatic control valves.

3.10 IDENTIFICATION

A. Identify system components.

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.
   1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Section 312000 "Earth Moving" for warning tapes.

3.11 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. 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.

C. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Any irrigation product will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.12 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that controllers are installed and connected according to the Contract Documents.
   3. Verify that electrical wiring installation complies with manufacturer's submittal.

3.13 ADJUSTING

A. Adjust settings of controllers.

B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.

C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch (13 mm) above, finish grade.

3.14 CLEANING

A. Flush dirt and debris from piping before installing sprinklers and other devices.

3.15 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

3.16 PIPING SCHEDULE

A. Install components having pressure rating equal to or greater than system operating pressure.

B. Piping in control-valve boxes and aboveground may be joined with flanges or unions instead of joints indicated.

C. Aboveground irrigation main piping, NPS 4 (DN 100) and smaller, shall be one of the following:
   1. Schedule 80, PVC pipe; socket-type PVC fittings; and solvent-cemented joints.

D. Underground irrigation main piping, NPS 4 (DN 100) and smaller shall be the following:
   1. SDR 21, PVC, pressure-rated pipe.

E. Circuit piping, NPS 2 (DN 50) and smaller, shall be one of the following:
   1. DR 9 PE, controlled OD pipe; PE butt, heat-fusion, or PE socket-type fittings; and heat-fusion joints.
   2. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
   3. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

F. Circuit piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
   1. DR 9 PE, controlled OD pipe; PE socket or butt-fusion fittings; and heat-fusion joints. NPS 3 (DN 80) pipe and fittings if NPS 2-1/2 (DN 65) pipe and fittings are not available.

2. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
3. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

G. Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.
1. Option: Plastic swing-joint assemblies, with offsets for flexible joints, manufactured for this application.

H. Drain piping shall be the following:
1. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.

3.17 VALVE SCHEDULE

A. Underground, Shutoff-Duty Valves: Use the following:

1. NPS 2 (DN 50) and Smaller: Curb valve, curb-valve casing, and shutoff rod.
2. NPS 3 (DN 80) and Larger: Iron gate valve, resilient seated; iron gate valve casing; and operating wrench(es).

B. Aboveground, Shutoff-Duty Valves:
1. NPS 2 (DN 50) and Smaller: Bronze gate valve.
2. NPS 2-1/2 (DN 65) and Larger: Iron gate valve, OS&Y.

C. Throttling-Duty Valves:

1. NPS 2 (DN 50) and Smaller: Plastic automatic control valve.
2. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Plastic automatic control valve.

D. Drain Valves:
1. NPS 1/2 and NPS 3/4 (DN 15 and DN 20): Bronze ball valve.
2. NPS 1/2 and NPS 3/4 (DN 15 and DN 20): Bronze gate valve.
3. NPS 1 to NPS 2 (DN 25 to DN 50): Bronze gate valve.

3.18 AS-BUILT

A. Final As-built of all items location and elevations prepared by a CT Licensed Land Surveyor in paper, Mylar and AutoCad format signed and sealed accuracy class A-2/T-2 for owner and engineer.

B. Final As-built of all items location and elevations .dwg file in AutoCAD Civil 3D format of as built prepared by a CT Licensed Land Surveyor with Civil 3D pipe networks.

END OF SECTION 328400

SECTION 329113 - SOIL PREPARATION

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 planting soils and layered soil assemblies specified by composition of the mixes.

B. Related Requirements
1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
2. Section 329200 "Turf and Grasses" for turf and grasses.

1.3 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

Q. USCC: U.S. Composting Council.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
    a. Manufacturer's qualified testing agency's certified analysis of standard products.
    b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1. Laboratories: Subject to compliance with requirements, provide testing by the following:
   a. University of Connecticut Soil Testing Lab Horticulture Storage Bdg., University of CT., 2019 Hillside Road, Storrs, CT 06260 tel. (860) 486-4274 for the following tests:

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Contractor will engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.
   1. Notify Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
   1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.8 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Architect under the direction of the testing agency.
   1. Number and Location of Samples: Minimum of ten representative soil samples from varied locations where directed by Architect for each soil to be used or amended for landscaping purposes.
   2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
   3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
   4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.9 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:
   1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
      a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
      b. Hydrometer Method: Report percentages of sand, silt, and clay.
   2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
   3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."

4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).

C. Chemical Testing:
1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.
5. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Soluble Salts, and Acidity (pH).

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NEC-67, including the following:
1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm and sodium absorption ratio.
14. Soluble-salts ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Soil analysis tests shall include recommendations for each of the tested soils for soil additives to correct soils deficiencies as necessary, to perform for their respective relationship to plant types including lawns. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm) depth of soil and per cubic yard

2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm)depth of soil.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

2.2 IMPORTED TOPSOIL

A. Imported Topsoil, shall be a naturally occurring soil formed from geologic soil forming processes without admixtures of sand or organic matter sources (composts) and shall be free of subsoil, large stones, earth clods, sticks, stumps, clay lumps, roots or other objectionable, extraneous matter or debris. Imported Topsoil shall also be free of quack-grass rhizomes, Agropyron Repens, and the nut-like tubers of nutgrass, Cyperus Esculentus, and all other primary noxious weeds. Imported Topsoil shall not be delivered or used for planting while in a frozen or muddy condition.

B. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches (100 mm) deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.

C. Gradation: Imported Topsoil for mixing shall conform to the following grain size distribution for material passing the #10 sieve:

U.S Sieve Size Number	Percent Passing	
	Minimum	Maximum
10	-	100

18	85	100
35	70	95
60	50	85
140	36	53
270	32	42
2 µm	3	8

1. The ratio of the particle size for 80% passing (D_{80}) to the particle size for 30% passing (D_{30}) shall be 8 or less. (D80/D30 < 8)
2. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample.

D. The organic content shall be between 4.0 and 8.0 percent.

E. The pH shall be between 5.5 and 7.0

F. Unacceptable Properties: Clean soil of the following:
1. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
2. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
3. Second option in "Large Materials" Subparagraph below allows generally acceptable soil clods to remain. Revise subparagraph to suit required soil structure, texture, and appearance.
4. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 3 inches (75 mm) in any dimension.

G. Add soil amendments and fertilizers as recommended by the testing lab from the following categories to produce viable planting soil.
1. Inorganic Soil Ammendments
2. Organic Soil Amendments
3. Fertilizers

2.3 PLANTING SOIL MIXES

A. General

B. Planting-Soil Type “Root Zone Medium 1”:
1. Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with imported topsoil in a ratio of 2 parts imported topsoil to 1 part existing soil.
2. Soil amendments and Fertilizers: Blended in place as recommended by the testing lab from the following categories to produce viable planting soil;
   a. Inorganic Soil Ammendments
   b. Organic Soil Amendments
   c. Fertilizers

C. Planting-Soil Type – “Root Zone Medium 2”
1. Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil with imported topsoil in a ratio of 2 parts imported topsoil to 1 part existing soil.

2. Soil amendments and Fertilizers: Blended in place as recommended by the testing lab from the following categories to produce viable planting soil;
   a. Inorganic Soil Ammendments
   b. Organic Soil Amendments
   c. Fertilizers

2.4 INORGANIC SOIL AMMENDMENTS AND FERTILIZERS:

A. The following soil components listed may have a particular application specified within this Section. Some of the soil components included shall be applied at rates determined by the soil tests called for under other paragraphs of this Section or as a result of soil tests. Some of the components may not be required by the soils test.

B. The following additives may or may not be used depending on the outcome of the soils report.
   1. Ground Limestone: Agricultural limestone containing not less than 85% of total carbonates, ground to such fineness that 50% will pass #100 sieve and 90% will pass #20 sieve.
   2. Dolomite Lime: Agricultural grade mineral soil conditioner containing 35% minimum magnesium carbonate and 49% minimum calcium carbonate, 100% passing #65 sieve. "Kaiser Dolomite 65 AG" as manufactured by Kaiser, Inc. Mineral Products Department, or equal.
   3. Gypsum: Agricultural grade product containing 90% minimum calcium sulfate dihydrate. Finely ground with 90 percent passing through a No. 50 (0.30-mm) sieve.
   4. Iron Sulfate (Ferric or Ferrous): Supplied by a commercial fertilizer supplier, containing 20% to 30% iron and 35% to 40% sulfur.
   5. Sulfate of Potash: Agricultural grade containing 50% to 53% of water-soluble potash.
   6. Single Superphosphate: Commercial product containing 20% to 25% available phosphoric acid.
   7. Ammonium Sulfate: Commercial product containing approximately 21% ammonia measured as nitrogen.
   8. Ammonium Phosphate: Commercial product containing approximately 18% ammonia measured as nitrogen and 48% phosphoric acid.
   9. Ammonium Nitrate: Commercial product containing approximately 17% ammonia measured as nitrogen and 17% nitrate nitrogen.
   10. Calcium Nitrate: Agricultural grade containing 15 ½% nitrogen and 21%calcium.
   11. Urea Formaldehyde (Urea-Form): Granular commercial product containing 38% slow release nitrogen with a minimum of 23% WIN (water insoluble nitrogen).
   12. I.B.D.U. (Iso Butyldiene Diurea): Commercial product containing 31% slow release nitrogen.
   13. Soil Sulfur: Agricultural grade sulfur containing a minimum of 96% sulfur. Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.
   14. Iron Sequestrene: Geigy Iron Sequestrene 138 Fe (Iron EDDHA)
   15. Iron Chelate Micronutrient: Sequestrene - 330 Fe; 0-0-0; ten (10%) percent Fe; Ciba-Geigy Company.
       a. Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.
   16. Gro-Safe: Herbicide absorbent as manufactured by American Norit Company of Jacksonville, FL (800) 641 9245).
   17. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.
   18. Perlite: Horticultural perlite, soil amendment grade.

2.5 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting and aerobic decomposition or organic residues. Compost shall be free of debris such as plastics, metal, concrete or other debris and stones larger than 1/2", larger branches and roots and wood chips over 1/2" in length or diameter. Compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices in conjunction with addition of fertilizer and other amendments as applicable, with no visible free water or dust, with no unpleasant odor, and meeting the following criteria as reported by laboratory tests.

1. Feedstock: Limited to leaves and yard waste composted for minimum 12 months
2. Reaction: pH of 6.0 to 7.5
3. Soluble-Salt Concentration: Less than 4 dS/m.
4. Moisture Content: 35 to 55 percent by weight.
5. Organic-Matter Content: 30 to 40 percent of dry weight.
6. Particle Size: Minimum of 98 percent passing through a 1-inch (25-mm) sieve.
7. Compost may be either commercially packaged or used in bulk form.
8. All compost shall be from DEEP regulated, permitted or approved facilities.
9. All compost material must be environmentally acceptable and must be accompanied by a Materials Certificate and Certified Test Report.
10. The Engineer reserves the right to draw samples and perform tests as may be deemed necessary to assure that the material meets these specifications.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch (13-mm) sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of 4 dS/m.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a 1/2-inch (13-mm) sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum 4 dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

1. Partially Decomposed Wood Derivatives: In lieu of shredded and composted wood derivatives, mix shredded and partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. (2.4 kg/cu. m) of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. (4 kg/cu. m) of loose sawdust or ground bark.

E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.6 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

2.7 FIBER REINFORCED SAND MIX:

A. Sharp, compactible sandy soil mix blended with fibers to support and stabilize lawns in designated event areas.
   1. Sieve Analysis of Sand shall be provided. Sand shall comply with the requirements and strictly fall within the particle size ranges and other criteria indicated in publications. Material shall be approved through agricultural and laboratory testing of particles and sieve sized. The following products/manufacturers mixes may be acceptable provided they meet the designated criteria:
      a. Turf Diagnostics & Design specifications for Sand Based Root Zone (ASTM F2396-04) for Sports fields. (613 E. 1st Street, Linwood, Kansas, (913) 723-3700. Web www.turfdiag.com ;
      b. TXI Dallas “TEE SAND” meeting USGA-01,
      c. Living Earth “TEE/FAIRWAY SAND” meeting California Recommendations for greens
   2. Percolation rate shall be approximately 10” per hour.
   3. Fertilizers and amendments as recommended by the agricultural testing laboratory are to be incorporated prior to installation of fibers and turf.
   4. Fibers:
      a. FIBERSOILS attn.: Jimmy Hill, P.O. Box 80198, Baton Rouge, LA 70898, 225.757.9136. Reference fiber soils specifications for additional information. www.fibersoils.com
      b. Product: Turfgrids 36MLGF blended at 6.75 LBS per cubic yard.
         1) If installing fibers with in-situ soil material, the requirement is to blend and till with Blekovater, Rotadarian or similar equipment.
         2) Compact to 95% density.
         3) Fiber Material may be pre-blended or blended off site.
   5. Geotextile:
      a. TenCate Mirafi FW400.
   6. Testing: Verify soil and filter fabric compatibility.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

C. Proceed with placement only after unsatisfactory conditions have been corrected.

D. All planting and lawn areas to receive full soil preparation

3.2 SOIL MOISTURE CONTENT

A. Moisture Content: Do not work soil when moisture content is so great that excessive compaction will occur, or when it is so dry that dust will form in air or clods will not break readily. Apply water, if necessary, to bring soil to an optimum moisture content for tilling and planting.

3.3 CLEARING AND SUBGRADE PREPARATION

A. Refer to project drawings for areas of lawn, planting beds (perennial, groundcover, and shrub) beds, landscaping berms, and tree planting locations

B. Excavation: Excavate soil from designated area(s) to depths indicated on drawings and stockpile until amended.

C. Verify Completion of rough grading to subgrade levels for lawn areas, planting beds, and landscaping berms.
   1. Lawn Areas: 18” Below Finished Grades
   2. Planting Beds (Perennials):
   3. Planting Beds Shrubs: 42”
   4. Landscaping Berms: 42”

D. Coordinate Scarification of subgrade compaction as a results of heavy construction activities in lawn and planting areas. Rip or cultivate all planting areas to a minimum depths indicated as follows immediately prior to amending existing soil. Rototill to reduce soil clods to a maximum diameter of one (1") inch in the top six (6”) inches.
   1. Heavy Construction Compacted Subgrade: Rip or cultivate to a minimum depth of 12 inches immediately prior to placing amended soils. In areas use for but not limited to material stockpile areas, temporary roadways, construction areas adjacent to building and similar areas.
   2. General Site Subgrade: Rip or cultivate to a minimum depth of 6 inches immediately prior to placing amended soils. Applies to all planting areas not applicable under above paragraph.

3.4 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

B. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

C. Screening: Pass unamended soil through a 2-inch (50-mm) sieve to remove large materials.

3.5 AMMENDING SOIL

A. Intent: Amendments and quantities are approximate and are for bidding purposes only. Following an on-site topsoil analysis by the approved Soils Testing Laboratory, composition of amendments may change. Contract Price will be adjusted accordingly.

B. Do not commence onsite soil amending until acceptance of subgrade.

C. Amending of Existing Soil: Application Rate: Apply to all planting and lawn areas at the following rates per 1,000 square feet:
   1. 6 cubic yards organic amendment as specified
   2. 20 pounds pre-plant fertilizer - 18-6-6 (N-P-K)
   3. Chemical additives per soils report.

D. Amending of Imported Topsoil: Application: Incorporate per 1,000 square feet.
   1. 6 cu. yd. Organic amendment
   2. 30 lbs. 19-0-0 Commercial Fertilizer
   3. 10 lbs. Iron Sulfate
   4. 10 lbs. Agricultural Gypsum
   5. Boil Sulphur: Agricultural grade sulphur containing a minimum of 96 percent sulphur. Apply at a rate of .2 lbs./1000 sq. ft.
   6. Zinc: .05 ounces/1000 sq. ft.
   7. Manganese: .05 ounces/1000 sq. ft.
   8. Copper: .05 ounces/1000 sq. ft.

E. Uniformly mix ingredients by a minimum of three mixing events with construction equipment on an approved hard surface area or by processing components through a screener. Organic Amendment and Topsoil shall be maintained moist, not wet, during mixing. Amendments shall not be added unless approved to extent and quantity by the Architect and additional tests have been conducted to verify type and quantity of amendment is acceptable. Percentages of components, unless otherwise noted, will be established upon completion of individual test results for components of the various mixes.

3.6 PLACING ROOT ZONE MEDIUM SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix root zone medium soil, with imported topsoil and amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches (100 mm). Remove stones larger than 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Apply approximately half the thickness of root zone medium soil over prepared, loosened subgrade. Mix thoroughly into top 4 inches (100 mm) of subgrade. Spread remainder of planting soil.

C. Mixing: Spread root zone medium soil to total depths indicated for lawn, planting beds, and landscaping berms, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
   1. Amendments: Apply soil amendments, compost, and fertilizer, if required, evenly on surface, and thoroughly blend them with existing on site oil and imported topsoil to produce planting soil.
      a. Mix lime and sulfur with dry soil before mixing fertilizer.
      b. Mix fertilizer with planting soil no more than seven days before planting.

   2. Lifts: Apply and mix the unamended soil, imported topsoil, and amendments in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each lift of planting soil to 82 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.7 PLACING AND MIXING PLANTING SOIL OVER EXPOSED ROOT ZONE MEDIUM 1 AND 2

A. General: Apply and mix imported soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Root zone medium Preparation: Till to a minimum depth of 4 inches (100 mm).

C. Mixing: Spread imported topsoil to total depths indicated for lawn, planting beds, and landscaping berms, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
   1. Amendments: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them with imported soil to produce planting soil.
      a. Mix lime and with dry soil before mixing fertilizer.
      b. Mix fertilizer with planting soil no more than seven days before planting.
   2. Lifts: Apply and mix imported soil and amendments in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.8 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix 4 inches (100 mm) of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.9 LAYERED SOIL ASSEMBLIES

A. Layered Soil Assembly: “Lawn Areas”

   1. Top Layer: Planting-soil type – Imported Top Soil.
   2. Lower Layer: Planting-soil type Root Zone Medium 1.

B. Layered Soil Assembly: “Planting Bed – Perennials”

1. Top Layer: Planting-soil type – Imported Top Soil.
2. Lower Layer: Planting-soil type Root Zone Medium 2.

C. Layered Soil Assembly: “Planting Bed – Shrubs”

1. Top Layer: Planting-soil type – Imported Top Soil.
2. Lower Layer: Planting-soil type Root Zone Medium 2.

D. Layered Soil Assembly: “Planting Bed – Landscaping Berm”

1. Top Layer: Planting-soil type – Imported Top Soil.
2. Lower Layer: Planting-soil type Root Zone Medium 2.

3.10 Fiber Reinforced Sand:

A. Place 8” to 12” of Specified Sand in 4-Inch Lifts to Specified Grade as noted on Plans.

B. Spread Fertilizer and Soil Amendments at the specified Addition Rate over the Sand Profile.

C. Spread / Mix Fertilizer and Soil Amendments with Initial Pass (First Pass) of Rotary Mixer(RotaDairon, Blecavator, or Equivalent).

D. Spread Turfgrids at an Application Rate of 1 LB / 8 SF to Specified Soil Profile. Turfgrids spread in specified area using Drop Spreader, Top Dresser, Modified StrawBlower, or Hand Spreading Application. Some Hand Raking may be required to obtain uniform coverage at specified addition rate.

E. Mix Turfgrids to 6” Depth with Rotary Mixer until uniform Fiber / Sand Composite is obtained. Typically 2 Passes at Right Angles with recommended Rotary Mixer. Equipment recommendations include Rotodairon, Blecavator, or Colari.

F. Compact Fiber Reinforced Sand to a minimum 95% Standard Proctor (ASTM D-698).

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests:

1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 2000 sq. ft. (200 sq. m) of in-place soil or part thereof.

C. Soil will be considered defective if it does not pass tests.
1. Prepare test reports.

D. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

E. Contractor shall bear final responsibility for proper surface drainage of planted areas. Any discrepancy in the Drawings or Specifications, obstructions on the site, or prior work done by another party, which Contractor feels precludes establishing proper drainage shall be brought to the attention of Architect in writing for correction or relief of said responsibility.

3.12 PROTECTION

A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

B. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.13 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

SECTION 329200 – TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Seeding.
2. Hydroseeding.
3. Meadow grasses and wildflowers.
4. Erosion-control material(s).

B. Related Requirements:
1. Section 31 10 00 "Site Cleaning".
2. Section 31 20 00 “Earth Moving”.
3. Section 33 46 00 "Subdrainage" for curtain drain and underdrain.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM C602, Specification for Agricultural Liming Materials.
2. ASTM D5268, Specification for Topsoil Used for Landscaping Purposes.

1.4 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.5 SUBMITTALS

A. Submit under provisions of Section 013300.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Product Certificates: For fertilizers, from manufacturer.

D. Planting Schedule: Indicating anticipated planting dates.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of meadows during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf and meadow establishment.

B. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

C. Topsoil Analysis: furnish soil analysis by a qualified soil-testing laboratory.
1. Submit topsoil test report from University of Connecticut Soil Testing Lab Horticulture Storage Bdg., University of CT., 2019 Hillside Road, Storrs, CT 06260 tel. (860) 486-4274 for the following tests:
   a. Nutrient Analysis
   b. PH
   c. Percent Organic Matter
   d. Textural Analysis
2. Soil Test reports shall include recommendations by Testing Lab for amendments to topsoil.
3. Contractor shall include this specification section when submitting topsoil samples to testing lab.
4. Topsoil testing costs shall be borne by the contractor.
5. Contractor shall provide one topsoil test for each 200 cubic yards of topsoil the project requires. Samples shall be distributed throughout the stockpile of topsoil material provided.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways, and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
   1. Spring Planting: March 15 to June 15.
   2. Fall Planting: August 15 to October 15.

B. Begin Maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
   1. Seeded lawns: 60 days from date of Substantial Completion.

C. Mow lawn as soon as top growth is tall enough to cut. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowing. Provide a minimum of two mowing cycles within the maintenance period.

D. Maintenance shall consist of watering, control of weeds, application of herbicide, re- fertilizing and re-seeding as necessary to achieve a fully established lawn as specified.

E. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions per manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Seed shall be manufactured by Lofts Seed (Pennington's) or approved equal. All grass seed shall be fresh, clean, of latest crop, and composed of the following varieties, mixed in proportions by weight testing to minimum percentages of purity and germination specified:

B. Seed Species:
   1. Seed Mixture for sun: Loft's Tri-Plex General Mixtures:
      a. Nassau Kentucky Bluegrass: 60%
      b. Jamestown II Chewings Fescue: 20%
      c. Palmer II Perennial Ryegrass: 20%
   2. Seed Mixture for shade: Loft's Tri-Plex Shade Mixtures:
      a. Shadow II Chewings Fescue: 65%
      b. Gold Rush Kentucky Bluegrass: 20%
      c. Palmer III Perennial Ryegrass: 15%
   3. Seed Mixture for multi-purpose: Loft's Athletic Field Mixture:
      a. Turf-Type Tall Fescue (3 Robel Varieties): 80%
      b. Palmer III Perennial Ryegrass: 10%
      c. Gold Rush Kentucky Bluegrass: 10%

C. Seed shall be delivered pre-mixed to the Site in standard size sealed containers bearing the vendor's guaranteed statement attesting to the composition of the mixture and to the percentages of purity and germination of each variety. Seed shall be stored in such manner that its effectiveness is not impaired. Samples of seed shall be taken as directed by the Construction Manager and/or Architect, and shall be submitted to the State Agricultural Station for analysis.

2.2 PLANTING MATERIALS

A. Topsoil: Topsoil shall meet requirements of CT DOT Form 817 M13.01.

B. Inorganic Soil Amendments:
1. Lime: agricultural ground dolomitic limestone meet CT DOT Form 817 Section M.13.02 with minimum calcium carbonate equivalent shall be 90.
2. The material must comply with the following gradation:
a. Square Mesh Sieves: Percentage Passing By Weight
1) Pass #10: 100
2) Pass #20: 90
3) Pass #100: 40
3. The Engineer reserves the right to draw such samples and perform such tests as he deems necessary to assure that these specifications are met
4. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.

C. Organic Soil Amendments
1. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8.
2. Peat: Finely divided or granular texture, with pH range of 6 to 7.5, containing partially decomposed moss peat, native, peat, or reed-sedge peat and having water-absorbing capacity of 1100 to 2200 percent.
3. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.

D. Fertilizer: Slow- Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition meeting CT DOT Form 817 Section M.13.03: Composition: 10 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

E. Mulches:
1. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
2. Peat Mulch: Finely divided or granular texture, with pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having high water absorbing capacity of 1100 to 2000 percent.
3. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8.
4. Wood Fiber Mulch: Shall be organic, dust free, bio-degradable, wood cellulose 100% recycled long fiber pulp, free of weeds or other foreign matter that might inhibit growth.

2.3 PLANTING SOIL MIX

A. See Section 329113 “Soil Prepration”

2.4 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: A manufactured blanket composed of biodegrable/photodegradable natural or polymer fibers and/or filaments that have been mechanically, structurally or chemically bound together to form a continuous matrix. Install in strict adherence to manufacturers application for use, requirements and recommendations.

B. Erosion-Control Mats: A manufactured mat composed of non-biodegradable polymer or synthetic fibers mechanically, structurally or chemically bound together to form a continuous. Install in strict adherence to manufacturers use application for use, requirements and recommendations at thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

C. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

D. Uniformly moisten excessively dry soil that is not workable or which is dusty.

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

F. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Construction Manager and/or Architect and replace with new planting soil.

3.2 LAWN PREPARATION

A. Newly Graded Subgrades: Loosen subgrade to a minimum depth of eight (8) inches. Remove stones larger than one (1) inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner’s property.

B. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planning soil mix.

C. If recommended as a result of topsoil analysis, lime shall be evenly distributed and thoroughly worked into the top three (3) inches of topsoil at the rate recommended by the soil analysis laboratory. Limestone shall be applied at least seven (7) days before applying fertilizer and chlordane. The ph content of topsoil shall be 6.0 to 7.0 before sod or seed is placed.

D. Commercial fertilizers shall be uniformly applied in all new grass areas. The application shall be within one week prior to placement seed at the rate recommended by the soil analysis laboratory, and worked lightly into the top two (2) inches of topsoil. Grass areas shall be watered thoroughly after the application of fertilizers.

E. Spread planting soil mix to a depth of six (6) inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

F. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
   1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
   2. Loosen surface soil to a depth of at least six (6) inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top four (4) inches. Till soil to a homogeneous mixture of fine texture.
   3. Remove stones larger than one (1) inch in any dimension and sticks, roots, trash, and other extraneous matter.
   4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
   5. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus ½ inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.
   6. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
   7. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

G. Changed Subgrades: See Specification Section 329113 'Soil Preparation'

H. All lines and grades required for proper performance of work shall be established by the Contractor in the field and shall meet with the Architect's approval. Prior to the commencement of the seeding operation a site inspection shall be made by the Construction Manager and Landscape Contractor. A letter of acceptance of the site conditions shall be received by the Construction Manager prior to the contractor commencing with the seeding operation.

3.3 SEEDING

A. Planting shall progress only under favorable weather conditions during the proper season for such work. Unless otherwise authorized in writing by the Construction Manager and/or Architect, the following shall apply: Grass seed shall be placed only between April 1st and June 15th or only between August 15th and October 15th.

B. Sow seeds at the following rate or as recommended by manufacturer:
   1. Sow seed mixture for sun at the rate of three and one half (3.5)lb/1000 sq ft.
   2. Sow seed mixture for shade at the rate of four (4) lb/sq ft.
   3. Sow seed mixture for multi-purpose fields at the rate of seven (7) 16/1000 sq ft.

C. Seeding shall be done on dry or moderately dry soil, and at times when wind does not exceed a velocity of five (5) miles per hour. Seeding shall be done in two directions, at right angles, in such a manner that a uniform stand shall result. Seed shall be sown evenly by hand, or with an approved mechanical spreader, to a depth not exceeding one-fourth (1/4) inch, at the rate of five (5) pounds per one thousand (1000) square feet, or 217 pounds per acre of lawn area. After seeding the surface shall be evenly and lightly raked with a fine wood-toothed rake or other approved method, and rolled in both directions with a hand roller weighing not more than on hundred (100) pounds per foot of width, and then watered thoroughly with a fine spray. Light sprayings shall be continued as required until the grass has become established. The Contractor is responsible for providing water for the establishment and maintenance of lawn areas. The Contractor shall take necessary precautions to keep the area undisturbed until grass is established.

D. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of two (2) tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment. Securing of straw mulch shall be at

the Contractor's discretion as to method or need and shall be his responsibility. Wood fiber mulch may be used in place of hay or straw at the rate of 1400 pounds per acre applied hydraulically at the same rate as the seed and fertilizer.

E. Areas which are on a slope steeper than one foot vertical to three feet horizontal or will receive concentrated run off of water shall receive 5 ounce burlap or jute netting 5 feet wide, joints to overlap not less than one foot. Material shall be secured by means of peg or other approved methods. Alternate methods approved by the Engineer may be used.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

B. Fill cells of erosion-control mat with planting soil and compact before planting.

C. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

D. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 HYDROSEEDING

A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

B. Mix slurry with non-asphaltic or fiber-mulch manufacturer's recommended tackifier.

C. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

D. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.6 TURF RENOVATION

A. Renovate existing turf where indicated.

B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

C. Reestablish turf where settlement or washouts occur or where minor re-grading is required.

D. Install new planting soil as required.

E. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

F. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

G. Mow, dethatch, core aerate, and rake existing turf.

H. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

I. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

J. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

K. Apply initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

L. Apply seed and protect with hay mulch as required for new turf.

M. Water newly planted areas and keep moist until new turf is established.

3.7 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.

C. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

D. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

E. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

F. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

G. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

H. The Contractor shall keep all seed areas free from weeds and debris, such as stones, cables, bailing wire, and he shall mow at his own expense, on a one-time only basis, all slopes 4:1 or flatter and level turf established areas to a height of 3 inches when the grass growth attains a height of 6 inches.

I. Turf Post fertilization: Apply commercial fertilizer after initial mowing and when grass is dry.

J. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove non-degradable erosion-control measures after grass establishment period.

3.9 INSPECTION AND ACCEPTANCE

A. All lawn areas will be inspected and accepted together, as one entire unit; and not in individual pieces, except as specifically authorized or directed by the Construction Manager and/or Owner.
   1. All seeded lawn areas will be inspected and accepted together.
   2. No lawn areas will be accepted prior to Substantial Completion of the Project, nor prior to the completion of a minimum of two mowings.

B. Seeded Turf: 60 days from date of Substantial Completion.

C. Submit Written Notice: requesting inspection.

D. Maintenance: responsibilities end with final acceptance.

E. A satisfactory sealed lawn which is acceptable is defined as:
   1. At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage.
   2. Any part of the lawn that does not show a uniform dense lawn grass shall be reseeded and maintained until satisfactory.

F. Final Acceptance: will not be made until all damaged areas, including areas outside the property limits have been restored to their original conditions by top soiling, seeding and other necessary operations.

G. Upon Stabilization of Lawn Areas: erosion control devices and protection fencing shall be removed and disposed of off-site.

3.10 AS BUILT

A. Final As-built of all site improvements location and elevations to be prepared by a CT Licensed surveyor and issued in paper, Mylar and AutoCad format, signed and sealed accuracy class A-2/T-2.

END OF SECTION 32 92 00

SECTION 329300 - PLANTS

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. Plants.
2. Tree stabilization.
3. Landscape edgings.

B. Related Requirements:
1. Section 32913 “Soil Preparation” for soil preparation.
2. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than sizes indicated; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than sizes indicated.

D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.

E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

G. Finish Grade: Elevation of finished surface of planting soil.

H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

I. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

J. Planting Area: Areas to be planted.

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.

L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

O. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst

quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

D. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in landscape installation.
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

    a. Landscape Industry Certified Technician - Exterior.
    b. Landscape Industry Certified Interior.
    c. Landscape Industry Certified Horticultural Technician.

5. Pesticide Applicator: State licensed, commercial.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Deliver bare-root stock plants within 36 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.

D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Handle planting stock by root ball.

F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.

G. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

H. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

I. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
1. Spring Planting: March 15 to June 15.
2. Fall Planting: August 15 to October 15.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
   b. Structural failures including plantings falling or blowing over.
   c. Faulty performance of tree stabilization and edgings
   d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of Substantial Completion.
   a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
   b. Ground Covers, Biennials, Perennials, and Other Plants: Nine months.
   c. Annuals: Three months.

3. Include the following remedial actions as a minimum:
   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
   d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

   1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots are unacceptable.
   2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

F. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 10-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.3 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood.
2. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
3. Color: Natural.

B. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:

1. Type: Rounded riverbed gravel or smooth-faced stone.
2. Size Range: 1-1/2 inches (38 mm) maximum, 3/4 inch (19 mm) minimum.
3. Color: Uniform tan-beige color range acceptable to Architect.

2.4 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

B. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd. (162 g/sq. m).

2.5 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated, pointed at one end.
2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles.
3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch (2.7 mm) in diameter.
4. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
5. Guy Cables: Five-strand, 3/16-inch- (4.8-mm-) diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches (75 mm) long, with two 3/8-inch (10-mm) galvanized eyebolts.
6. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.

B. Root-Ball Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated; stakes pointed at one end.
2. Wood Screws: ASME B18.6.1.

C. Palm Bracing: Battens or blocks, struts, straps, and protective padding.

1. Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-4-inch nominal (38-by-89-mm actual) by lengths indicated.
2. Straps: Adjustable steel or plastic package banding.
3. Padding: Burlap.

2.7 LANDSCAPE EDGINGS

A. Plastic Edging: Standard black polyethylene or vinyl edging, V-lipped bottom, extruded in standard lengths, with 9-inch (225-mm) steel angle stakes.
1. Edging Size: See Drawings.
2. Top Profile: See Drawings.
3. Accessories: Manufacturer's standard alignment clips or plugs.

2.8 TREE-WATERING DEVICES

A. Watering Pipe: PVC pipe 4 inches (100 mm) in diameter, site-cut to length as required, and with snug-fitting removable cap.

2.9 MISCELLANEOUS PRODUCTS

A. Wood Pressure-Preservative Treatment: AWPA U1, Use Category UC4a; acceptable to authorities having jurisdiction, and containing no arsenic or chromium.

B. Root Barrier: Black, molded, modular panels, 85 mils (2.2 mm) thick, and with vertical root deflecting ribs protruding 3/4 inch (19 mm) out from panel surface; manufactured with minimum 50 percent recycled polyethylene plastic with UV inhibitors.

C. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

D. Burlap: Non-synthetic, biodegradable.

E. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.

F. Planter Filter Fabric: Nonwoven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.

G. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb (0.45 kg) of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb (0.45 kg) of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.

C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Application of Mycorrhizal Fungi: At time directed by Architect, broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
3. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected overnight, after working hours, and when unattended by Installer's personnel.
9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.

1. Backfill: Planting soil as specified.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
    a. Quantity: Three for each caliper inch of plant.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Watering Pipe: During backfilling, install watering pipe 4 feet (1.25 m) deep into the planting pit outside the root ball with top of pipe 1 inch (25 mm) above the mulched surface.

E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying: Stake trees of 2- through 5-inch (50- through 125-mm) caliper. Stake trees of less than 2-inch (50-mm) caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches (450 mm) below bottom of backfilled excavation and to extend one-third of trunk height above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.

1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of the vertical stakes.

a. Install stakes of length required to penetrate at least to the dimension indicated on Drawings below bottom of backfilled excavation. Saw stakes off at horizontal stake.
b. Install screws through horizontal hold-down and penetrating at least 1 inch (25 mm) into stakes. Predrill holes if necessary to prevent splitting wood.
c. Install second set of stakes on other side of root trunk for larger trees.

2. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.8 ROOT-BARRIER INSTALLATION

A. Install root barrier where trees are planted within 60 inches (1500 mm) of paving or other hardscape elements, such as walls, curbs, and walkways, unless otherwise indicated on Drawings.

B. Align root barrier vertically, and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.

C. Install root barrier continuously for a distance of 60 inches (1500 mm) in each direction from the tree trunk, for a total distance of 10 feet (3 m) per tree. If trees are spaced closer, use a single continuous piece of root barrier.
1. Position top of root barrier 1/2 inch (13 mm) above finish grade or according to manufacturer's written recommendations.
2. Overlap root barrier a minimum of 12 inches (300 mm) at joints.
3. Do not distort or bend root barrier during construction activities.
4. Do not install root barrier surrounding the root ball of tree.

3.9 PLACING SOIL IN PLANTERS

A. Fill planter with planting soil as specified. Place soil in lightly compacted layers to an elevation of 1-1/2 inches (38 mm) below top of planter, allowing natural settlement.

3.10 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil as specified for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.11 PLANTING AREA MULCHING

A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 12 inches (300mm) and secure seams with galvanized pins.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch (75-mm) average thickness, with radius round trunks or stems indicated on drawings. Do not place mulch within 3 inches (75 mm) of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 3-inch (75-mm) average thickness of organic mulch over whole surface of planting area indicated on drawings, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) of trunks or stems.

3.12 EDGING INSTALLATION

A. Plastic Edging: Install plastic edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 36 inches (900 mm) apart, driven through upper base grooves or V-lip of edging.

3.13 INSTALLING SLOW-RELEASE WATERING DEVICE

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.14 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.15 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.16 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than 25> percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size as those being replaced for each tree of 4 inches (100 mm) or smaller in caliper size.

2. Provide two new tree(s) of 4-inch (100-mm) caliper size for each tree being replaced that measures more than 6 inches (150 mm) caliper size.
3. Species of Replacement Trees: Species selected by Architect.

3.17 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completio**n**, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.18 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: 12 months from date of Substantial Completion.

B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: Six months from date of Substantial Completion.

3.19 AS-BUILT

A. Final As-built of all items location and elevations prepared by a CT Licensed Land Surveyor in paper, Mylar and AutoCad format signed and sealed accuracy class A-2/T-2 for owner and engineer.

END OF SECTION 329300

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."

1.2 GREEN BUILDING REQUIREMENTS

A. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include complying with CTHPB standards. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling and an indoor quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the sections below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental compliance goals

1.3 SUMMARY

A. This Section includes storm drainage outside the building, as follow:
   1. Pipe and fittings.
   2. Nonpressure transition couplings.
   3. Expansion joints and deflection fittings.
   4. Backwater valves.
   5. Cleanouts.
   6. Drains.
   7. Encasement for piping.
   8. Manholes.
   9. Channel drainage systems.
   10. Catch basins.
   11. Stormwater inlets.
   12. Stormwater detention structures.
   13. Pipe outlets.

B. Related Sections include the following:
   1. Division 33 Section "Subdrainage" for curtain drain and underdrains

1.4 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

B. RCP: Reinforced concrete pipe

C. HDPE: High Density Polyethylene

D. ACO DRAIN: Polymer concrete pre-sloped trench drain

1.5 SUBMITTALS

A. Product Data: For the following:
1. PVC Polyvinyl chloride pipe as shown on the drawings.
2. RCP Reinforced concrete pipe as shown on the drawings.
3. HEPE- High Density Polyethylene pipe or approved equal as shown on the drawings.
4. Cleanouts as shown on the drawings.
5. Manholes as shown on the drawings.
6. Catch basins as shown on the drawings.
7. PVC yard drains as shown on the drawings.
8. Subsurface detention basins as shown on the drawings.
9. Storm water discharge structures as shown on the drawings.
10. Geotextile as shown on the drawings.
11. Non- pressure transition couplings and fittings.
12. Concrete encasement for piping, if require.

B. Shop Drawings: Include plans, elevations, details, and attachments for the following:
1. Pre-cast concrete structures, including inserts, baffles, offices, pipes inverts in and out, frames, covers, grates, and other that applies to concrete structures.
2. Subsurface detention basins, including piping, fittings, inverts in and out, inspection port, cleanouts, frames, covers, grates, geotextile, stone, and other that applies to the basin.
3. Drains with ADA accessible, catch basins, inverts in and out, tamper resistant cast iron grates and other that applies to drains.
4. Cleanouts, including frames, covers, grates and other that applies to cleanouts.
5. PVC yard drains with cast iron grates and other that applies to drains.

C. Coordination Drawings: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.

D. Coordination Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 40 feet (1:500) and vertical scale of not less than 1 inch equals 4 feet (1:50). Indicate underground structures and pipe. Show types, sizes, materials, and elevations of other utilities crossing system piping.

E. Design Mix Reports and Calculations: For each class of cast-in-place concrete.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

G. Performance Documentation

1. Storm water quality structures. The following documentation must be submitted by the Contractor and approved by the Engineer prior to the manufacture and delivery of any materials.

a. Laboratory Data. The Storm water quality structures supplier shall provide documentation of Total Suspended Solids (TSS) removal efficiency from laboratory testing conducted on the supplier's full-scale system. The documentation shall include:
1) Removal efficiency versus operating rate for the full operating range of the stormwater treatment system for a 50-micron particle size.
2) Removal calculations for each system specified herein. The calculations must demonstrate that the system(s) can achieve a net annual TSS removal efficiency as

required by local regulations and as based upon a 50-micron particle size and the best available rainfall data for the project site location.

b. Field Test Data. The Storm water quality structures supplier shall provide documentation of TSS removal efficiency from field testing conducted on an installed system. The documentation shall be in accordance with the following:
   1) The testing and documentation shall have been conducted by an independent third party.
   2) The testing and documentation shall include at least 10 storms.
   3) The testing and documentation must show TSS removal results that meet or exceed the performance requirements for the system(s) specified herein.

c. Manufacturing Experience. The Storm water quality structure supplier shall provide evidence of at least 5 years of successful product design and use. The supplier shall provide an installation list of projects, model sizes installed and installation dates where the same type systems as specified herein have been designed and produced by the supplier.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle pre-cast concrete and PVC structures, and other structures according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. It is contractor's responsibility and expense to engage a Professional Engineer licensed in The State of Connecticut to perform supervision of installation of the Underground storm water detention system. The installation of all Underground storm water detention system on the site to be done under the supervision of this engineer.

B. After construction is completed, the engineer who supervised the installation of the Underground storm water detention system on the site is to submit to the Town of Rocky Hill written certification that the system was installed as per the approved design.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Construction Manager and/or Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Construction Manager and/or Architect's written permission.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. All pipes and fittings shall comply with requirements of the Town of Rocky Hill Engineering Department, Standard Details and Specifications.

B. HDPE PIPE AND FITTINGS
1. Corrugated Polyethylene Pipe, either corrugated interior surface (Type C) or smooth interior surface (Type S) without perforations or with perforations (Type CP or SP), shall conform to AASHTO M 252 or M 294. Type D pipe shall have a smooth interior surface braced circumferentially or spirally with projections or ribs joined to a smooth outer wall. Both surfaces shall be fused to, or be continuous with, the internal supports. Type D shall conform to AASHTO M 294.
2. The solid or perforated pipe for this work shall conform to the following requirements:
   a. 4- through 12-inch pipe (per AASHTO) for use in gravity-flow drainage applications. The pipe (per AASHTO) shall have smooth interior and annular exterior corrugations.
   b. 4- through10-inch shall meet AASHTO M252, Type S or SP.
   c. 12- through 60-inch shall meet AASHTO M294, Type S or SP or ASTM F2306.
3. Fittings shall conform to AASHTO M252, AASHTO M294, or ASTM F2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of AASHTO M252, AASHTO M294 or ASTM F2306.

C. PVC Water-Service Piping:
1. Pipe: ASTM D 1785, Schedule 40 PVC, with plain ends for solvent-cemented joints.
2. Fittings: ASTM D 2466, Schedule 40 PVC, socket type.

D. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, Class III - V, Wall B.
1. Bell-and-spigot or tongue-and-groove ends and gasketed joints with ASTM C 443, rubber gaskets.
2. Pipes and gasketed joints conform to the requirements of section M.08.01-6 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current supplemental and editions.

2.2 NONPRESSURE TRANSITION COUPLINGS

A. Nonpressure Transition Couplings shall comply with requirements of the Town of Rocky Hill Engineering Department, Standard Details and Specifications.

B. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Sleeve Materials:
1. For Concrete Pipes: ASTM C 443, rubber.
2. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

D. Unshielded, Flexible Couplings:
1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

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

F. Ring-Type, Flexible Couplings:
   1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.3 BEDDING AND BACKFILL MATERIAL

A. Bedding and Backfill shall comply with requirements of the Town of Rocky Hill Engineering Department, Standard Details and Specifications.

B. Suitable material shall be class I, II or III. The contractor shall provide documentation for material specification to engineer. Unless otherwise noted by the engineer, minimum bedding thickness shall be 6".

C. Bedding shall be ¾" crushed stone conforming to the requirements of Section M.01.01 for No.6 stone of the State of Connecticut Department of Transportation "Standard Specifications for Roads, Bridges and Incidental Construction", Form 817, including current supplemental and edition.

2.4 GEOTEXTILE FABRIC

A. Geotextile Fabric shall comply with requirements of the Town of Rocky Hill Engineering Department, Standard Details and Specifications.

B. The geotextile shall be non-rotting, acid and alkali resistant and have sufficient strength and permeability for the purpose intended, including handling and backfilling operations. Fibers shall be low water absorbent. The fiber network must be dimensionally stable and resistant to delamination. The geotextile shall be free of any chemical treatment or coating that will reduce its permeability. The geotextile shall also be free of any flaws or defects, which will alter its physical properties. Torn or punctured geotextiles shall not be used. For each specific use, only geotextiles, which are already on the Connecticut Department of Transportation's "Qualified Products List" for the geotextile type, will be used. The Engineer reserves the right to reject any geotextile, which he deems unsatisfactory for a specific use. The brand name shall be labeled on the geotextile or the geotextile container. Geotextiles, which are susceptible to damage from sunlight or heat, shall be so identified by suitable warning information on the packaging material.

C. Geotextiles susceptible to sunlight damage shall not be used in any installations where exposure to light will exceed 30 days, unless specifically authorized in writing by the Engineer.

2.5 MANHOLES

A. Normal-Traffic H-20, Pre-cast Concrete Manholes: ASTM C 478, pre-cast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints conforming to the requirements of Section 5.07 of the State of Connecticut Department of Transportation "Standard Specifications for Road, Bridge and Incidental Construction", Form 817 as amended and including the current supplemental specifications and the City Danbury standard details and specifications.
   1. Diameter: 48 inches minimum, unless otherwise indicated.
   2. Ballast: Increase thickness of pre-cast concrete sections or add concrete to base section, as required to prevent flotation.
   3. Base Section: 12-inch minimum thickness for floor slab and 8-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
   4. Riser Sections: 8-inch minimum thickness, and lengths to provide depth indicated.
   5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

6. Gaskets: ASTM C 443, rubber.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9-inch total thickness, that match 24-inch diameter frame and cover.
8. Steps: Copolymer Polypropylene plastic steel reinforced, as indicated. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.

B. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

C. Manhole Frames and Covers: To meet the Town of Rocky Hill requirements and Standard Details.

2.6 CATCH BASINS

A. Normal-Traffic, Pre-cast Concrete Catch Basins: ASTM C 478, pre-cast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints conforming to the requirements of Section 5.07 of the State of Connecticut Department of Transportation "Standard Specifications for Road, Bridge and Incidental Construction", Form 817 as amended and including the current supplemental specifications.
1. Base Section: 6-inch minimum thickness for floor slab and 8-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
2. Riser Sections: 8-inch minimum thickness, size as indicated, and lengths to provide depth indicated.
3. Top Section: Pre-cast concrete, size as indicated.
4. Gaskets: ASTM C 443, rubber.
5. Grade Rings: Reinforced-concrete rings, of 6- to 9-inch total thickness.
6. Steps: Copolymer Polypropylene plastic steel reinforced, as indicated. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
7. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A 48-83, gray iron castings designed for heavy-duty service, Type A, galvanized, conforming to the requirements of section M.08.02-5 of the State of Connecticut Department of Transportation "Standard Specifications for Road, Bridge and Incidental Construction", Form 817 as amended and including the current supplemental specifications and the Town of Rocky Hill standard details and specifications. Include flat grate with small square or short-slotted drainage openings.
1. Size: as indicated.
2. Grate Free Area: Greater than 50 percent, unless otherwise indicated.

2.7 DISCHARGE STRUCTURES

A. Normal-Traffic H-20, Pre-cast Concrete Structures: ASTM C 478, pre-cast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints conforming to the requirements of Section 5.07 of the State of Connecticut Department of Transportation "Standard Specifications for Road, Bridge and Incidental Construction", Form 817, including current supplemental and Town of Fairfield current details.
1. Inside Width: 48 inches minimum, unless otherwise indicated.
2. Ballast: Increase thickness of pre-cast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: 6-inch minimum thickness for floor slab and 8-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
4. Riser Sections: 8-inch minimum thickness, and lengths to provide depth indicated.

5. Top Section: flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Gaskets: ASTM C 443, rubber.
7. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9-inch total thickness, that match 24-inch diameter frame and cover.
8. Steps: Copolymer Polypropylene plastic steel reinforced, as indicated. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
9. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Discharge Structure Frames and Covers: ASTM A 48-83, gray iron castings designed for heavy-duty service. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch diameter cover. Include indented top design with Town of Fairfield storm drainage lettering cast into cover.

2.8 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: Class C or F 4000 psi minimum, with 0.45 maximum water-cementitious ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed steel.

2.9 CLEANOUTS

A. PVC Cleanouts:
1. Basis-of-Design Product: Subject to compliance with requirements, provided on the drawings.
2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser as shown on detail. Provide gray, cast - iron frame and cover as shown in the details.
3. Top-Loading Classification(s): Heavy Duty or as noted on the drawings.

2.10 PVC YARD DRAINS

A. PVC Basin:
1. Used PVC Drain Basin. Materials shall conform to Form 817, Section M.08.01. Integrated Ductile Iron frame and grade to match basin O.D. and rated for AASHTO H-20 or H-10 loading as noted on the drawings. Construct 8–inch. minimum concrete slab for AASHTO H-20 loading around the frame as show on details. Grates shall be ductile iron per ASTM A536 Grade 70-50-05. 24-inch. frame shall be ductile iron per ASTM A536 Grade 70-50-05. 12-inch. frame cast iron per ASTM A-48-83 Class 30B. Yard Drain basin to be custom manufactured according to plan details. Drainage connection stub joint tightness shall confirm to ASTM D3212. Shop drawings shall be submitted to Engineer for approval.

B. Backfill material below and to side of structure shall be ASTM D2321 Class 1 or Class 2 size ¾” crushed stone or gravel and be placed uniformly in 6-inch. lifts and compacted to a min. of 90%.

2.11 RUBBER BACKWATER VALVES

A. Basis-of-Design Product: Subject to compliance with requirements, provide on drawings or comparable product.

B. Description: back water valves are to be all rubber and the flow operated check type with slip-in cuff connection. The valve shall be ply reinforced throughout the body, disc and bill, which is cured and vulcanized into a one-piece unibody construction. The valve shall be manufactured with no metal, mechanical hinges or fasteners, which would be used to secure any component of the valve to a valve housing. The port area of the disc shall contour into a circumferential sealing area concentric with the pipe which shall allow passage of flow in one direction while preventing reverse flow. The entire valve shall fit within the pipe inside diameter.

C. Valves will be furnished with a set of stainless steel expansion clamps. The clamps, which will secure the valve in place, shall be installed in the upstream or downstream cuff of the valve, depending on installation orientation, and shall expand outwards by means of a turnbuckle. Each band shall be pre-drilled allowing for the valve to be pinned and secured into position in accordance with the manufacturer's installation instructions.

D. The outside diameter of the upstream and downstream sections of the valve must be circumferentially in contact with the inside diameter of the pipe.

E. Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

2.12 TRENCH DRAINS WITH ADA ACCESSIBLE GRATE SYSTEMS

A. General Requirements for Polymer-Concrete, Channel Drainage Systems: Modular system of pre-cast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.

B. Basis-of-Design Product: Subject to compliance with requirements, indicated on drawings or comparable product,

C. Wide-Width, Level-Invert, Polymer-Concrete Systems:
1. Channel Sections:
   a. Interlocking-joint, pre-cast, modular units with end caps.
   b. Dimensions of the inside width and deep as specified on the details, rounded bottom, with level invert and with outlets in quantities, sizes, and locations indicated.
2. Grates:
   a. Slots or other openings that fit recesses in channels that meets ADA requirements.
   b. Material: Gray iron.
3. Covers: Solid gray iron if indicated.
4. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

D. Drainage Specialties: Pre-cast, polymer-concrete units.
1. Large Catch Basins:
   a. 24-by-12-inch polymer-concrete body, with outlets in quantities and sizes indicated.
   b. Gray-iron slotted grate that meets ADA requirements.
   c. Frame: Include gray-iron or steel frame for grate.

E. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
1. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.13 STORM WATER QUALITY STRUCTURES

A. Storm water quality structures shall be pre-manufactured systems designed to remove settleable and floating pollutants in storm water using vortechnic technology. Storm water quality structures shall be designed for these flow applications with complete high-level bypass in case of clogging. These units shall be constructed of reinforced concrete with full manhole access and according to ASTM C890 for HS-20 traffic loads. Structure shall be designed to prevent buoyancy.

2.14 SUBSURFACE DETENTION BASIN

A. The materials to be used in the construction shall be those indicated on the drawings and details and they shall conform to the requirements of these specifications.
   1. The system: All precast concrete structures and components shall be manufactured in accordance with the approved design shop drawings.

B. Subsurface detention system shall be custom manufactured according to plan details. Drainage connection stub joint tightness shall confirm to ASTM D3212.

C. Contractor shall supply shop drawings for review and approval prior to installation. Drawings shall include dimensions, elevations and configuration of the system, including any internal flow controls; attenuation channels, weirs, baffles, orifices and overflow devices. They shall also include inlet splash pads, sumps and outlet control structures. The drawings shall identify and detail all roof access openings and inlet/outlet pipe openings.

D. Precast Concrete
   1. Precast concrete shall be manufactured by a NPCA certified plant.
   2. Precast vendor shall submit structural calculations prepared by a licensed Professional Engineer licensed in the state of installation.
   3. Precast concrete shall be a minimum of 5000psi @ 28 days.
   4. Reinforcing shall conform to latest ASTM A615.
   5. Design shall conform to H-20 Loading conditions per AASHTO HS-20-44.
   6. Precast vendor shall supply sufficient lifting devices cast into the structures capable of supporting structure.

E. Structural Design
   1. Soil strength shall be verified to be a minimum of 3000 psf soil bearing capacity. Soil density is assumed to be 120 PCF.
   2. Subgrade soils shall be compacted to a 95% density.
   3. Water table level shall be verified to be below the system structural section for structural and buoyancy conditions. If ground water elevation is higher than the structure base, buoyancy calculations shall be submitted.
   4. Structural buoyancy calculations shall assume the concrete density to be 150 psi. Soils above units (structural column) can be considered in the calculations assuming soil density to 120 psi. The effects of sidewall friction shall not be used in calculation.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installing green warning detectable tapes directly over piping and at outside edges of underground structures.
   1. Use detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.3 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

F. Install piping pitched down in direction of flow, at minimum slope of 0.5 percent, unless otherwise indicated.

G. Extend storm drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

3.4 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to installations indicated.

B. PVC Sewer Pipe and Fittings: As follows:
   1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
   2. Install according to ASTM D 2321.

C. HDPE Pipe and fittings:
   1. Pipe shall be joined with the AASHTO WT IB joint meeting the requirements of AASHTO M252, ASSHTO M294 or ASTM F2306.
   2. 4- through 60-inch shall be watertight according to the requirements of ASTM D3212. Gaskets shall be made from plyisoprene meeting the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly.
   3. Pipes shall have a reinforced bell with a bell tolerance device. The bell tolerance device shall be installed by the manufacturer.

4. Fittings shall conform to AASHTO M252, AASHTO M294 or ASTM F2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the watertight joint performance requirements of AASHTO M252, AASHTO M294 or ASTM F2306.
5. Field Pipe and Joint Performance: To assure Watertightness, field performance verification may be accomplished by testing in accordance with ASTM F248. Appropriate safety precautions must be used when field testing any pipe material. Contact the manufacturer for recommended leakage rates.

D. Concrete Pipe and Fittings: Install according to ACPA's "Concrete Pipe Installation Manual." Use the following seals:
1. Round Pipe and Fittings: ASTM C 443, rubber gaskets.

E. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.5 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.

C. Install pre-cast concrete manhole sections with gaskets according to ASTM C 891.

3.6 CATCH-BASIN, YARD DRAIN AND SLOT DRAIN INSTALLATION

A. Construct catch basins, yard drains and slot drain to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.7 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.8 BACKWATER VALVES

A. Construct according to manufacturer recommendations and as indicated on the plans and details.

3.9 SUBSURFACE DETENTION BASIN

A. Installation shall be in accordance with the approved engineering drawings, specifications and calculations. Location, dimensions, elevations, pipe sizes and access manholes shall be per plan.

B. Contractor shall obtain and be familiar with product installation guide.

C. Contractor shall excavate the installation area to the specified subgrade elevation. Subgrade soils shall be graded to a consistent level bed, free from deleterious materials such as organics, trash and debris. Subgrades shall be compacted to a 95% density.

D. For detention systems, contractor shall place a waterproof membrane (PPL-24, 24mil containment membrane supplied by Carthage Mills, or approved equal)) sandwiched between fabric pads (803 PROPEX 801 non-woven geotextile by Carthage Mills or approved equal) over complete base and sides

of the excavation walls. Membrane / fabric pads shall be wrapped so as to contain the required crushed stone base section specified and to isolate the exterior perimeter of the structures from the native material backfill. Fabric shall be wrapped over the top of the structures a minimum of 4'. Fabric shall be installed in such fashion so as to create a waterproof wrap whereas the corner folds overlap and are folding into an upward position to prevent water from entering. ConSeal CS-212 "ribbon tape" may be used to adhere and keep membrane/fabric materials in place during excavation and backfill operations.

E. A minimum of 6" of ¾"+ crushed stone base placed in a 95% compacted level grade shall be installed on top of the filter fabric in the bottom of the excavation.

F. Precast concrete (or cast in place) inlet splash pads shall be installed to the specified grade and locations per plan.

G. Structures shall be installed in a level and plumb fashion so as to minimize the gap between structures to no more than an average of ¼" and no greater than ½" gap. Unless noted, all structure bottom and top elevations shall be equal to within ½".

H. Exterior top joints shall be sealed with ConSeal CS-212 (.065 thick x 6" wide) "ribbon tape", or approved equal. "Ribbon tape" shall be applied to a clean dry surface that may require surface preparation to apply per manufactures recommendations. "Ribbon tape" shall be applied in a continuous length; although when required, a minimum of a 12" overlay can be utilized.

I. All pipe inverts shall be installed per specified elevation. Installation of the inlet/outlet pipes with a membrane system shall incorporate a watertight rubber boot and flange gasket kit supplied by the vender. The rubber boot shall be installed inside the pipe hole cut into the structure wall. Hole shall be clean and smooth and free of loose or foreign material. The rubber boot should fit tightly and snug against the receiving concrete wall section. The internal metal expansion ring should be tightened to the manufactures recommended torque. The pipe should be slipped into the rubber boot and the external metal pipe clamp should be tightened down to the manufactures recommended torque. When using corrugated pipe, a pipe adapter may be supplied by the pipe vendor to fill the cavity and produce a flat surface to connect the pipe boot to. Those materials may be a Conseal CS-102 "rope tar" or ConSeal CS-212 "ribbon tape" material or a watertight caulking such as Sikaflex 1a construction sealant.

J. Watertight detention systems will require the installation of a flanged gasket plate sealing the membrane against the wall of the concrete structure. The flange plate consists of a flange ring with an inside hole dimensioned larger than the pipe OD, and predrilled holes to insert the Power-Studs through.. Contractor shall place a minimum of one layer in a continuous band of ConSeal CS-212 "ribbon tape" applied against a clean smooth structure outside wall. The membrane shall have a hole cut large enough to fit the OD of the pipe thru at the location of the pipe protrusion. The membrane can then be pressed against the band of the CS-212, compressing and adhering to the band to the membrane. The flange ring can then be placed around the opening in the membrane, pressed into place and then fastened by Power-Stud threaded expanded fastener. Use minimum number #4 for smaller diameters and as many as required to ensure ring seats in a flat watertight fit. Torque down nuts to hold in place. Note that any wall perforation holes that are visible between the ID of the ring and the OD of the pipe shall be filled with a waterproof grout mix.

K. For infiltration systems a masonry grout filled pipe hole is sufficient.

L. For internal piping configurations, a rubber boot system or masonry grout filled pipe hole is sufficient.

M. Internal flow control structure shall be installed per plan specifications.

N. Contractor shall install manhole access structures per plan specifications.

O. For bedding of Subsurface detention system use Suitable material shall be class I, II or III. The contractor shall provide documentation for material specification to engineer. Unless otherwise noted by the engineer, minimum bedding thickness shall be 6". See plans and details. Fill shall be placed in 9” lifts at 95% compaction. All fill should not contain any deleterious materials or stones larger than 3” diameter within 6” of system top.

3.10 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plug in end of incomplete piping at end of day and when work stops.
3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Re-inspect and repeat procedure until results are satisfactory.

C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects:
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate reports for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
b. Option: Test plastic piping according to ASTM F 1417.
c. Option: Test concrete piping according to ASTM C 924
6. Leaks and loss in test pressure constitute defects that must be repaired.
7. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.11 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with water.

3.12 AS-BUILT

A. Final As-built of all items location and elevations shall be prepared by a Connecticut Licensed Land Surveyor in paper, Mylar and AutoCAD format and to be provided to property owner and engineer.

B. Final As-built of all items location and elevations .dwg file in AutoCAD Civil 3D format of as built prepared by a CT Licensed Land Surveyor with Civil 3D pipe networks.

C. After construction is completed, the engineer who supervised the installation of the Underground storm water detention system on the site is to submit to the Town of Rocky Hill written certification that the system was installed as per the approved design.

END OF SECTION 33 41 00

SECTION 334600 – SUBDRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Underdrain Drainage.
   2. Curtain Drain.
   3. Geotextile filter fabrics.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Drainage Pipe
   2. Drainage Stone.
   3. Geotextile filter fabrics.

1.4 PROJECT CONDITIONS

A. Call “CALL BEFORE YOU DIG (1-800-922-4455)“ 72 hours prior to any excavation.

PART 2 - PRODUCTS

2.1 RETAINING WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:
   1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
   2. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

2.2 UNDERDRAIN DRAINAGE AND CURTAIN DRAIN

A. Single perforated pipe surrounded by crushed clean stone (size as specified on the plans and details) and wrapped in geotextile filter fabric.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product.

2. Nominal Size: as shown on the plans and details
3. Fittings: HDPE with combination NPS outlet connection size as shown on the plans and details.
4. Couplings: Corrugated HDPE band.

B. Crushed clean stone size as specified on the plans and details. Contractor to provide sieve analysis from Manufacturer that the stone meets required specification.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product.
2. Filter Fabric: Comply with requirements for non - woven filter fabric as listed on Qualified product list for CT DOT Projects for intended use.

2.3 SOIL MATERIALS

A. Soil materials are specified in Section 312000 "Earth Moving."

2.4 GEOTEXTILE FILTER FABRICS

A. Description: Comply with requirements for non - woven filter fabric as listed on Qualified product list for CT DOT Projects for intended use.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where sub-drainage systems are to be installed.

B. When sub-drainage is required for road base drainage and curtain drain, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

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

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 RETAINING WALL DRAINAGE INSTALLATION

A. Excavate trench.

B. Building retaining wall.

C. Behind the retaining wall lay geotextile filter fabric in trench and overlap trench sides

D. Install bedding for the perforated pipe as shown on the Plans and Details.

E. Install drainage piping as indicated on the Plans and Details.

F. Add crushed clean stone in 12 inch lifts and compact as shown on the Plans and Details.

G. Place backfill around each 12 inch lift and compact as shown on the Plans and Details.

H. Repeat procedure until stone reaches designed depth.

I. Wrap pipe and crushed stone with filter fabric. Overlap the filter fabric at least 6 inches.

J. Fill to Grade: Place satisfactory topsoil over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.4 UUNDERDRAIN AND CURTAIN DRAIN INSTALLATION

A. Provide trench width to allow installation of underdrain or curtain drain. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay geotextile filter fabric in trench and overlap trench sides.

C. Place 4 inches of size 3/8" crushed clean stone layer over compacted sub-grade and geotextile filter fabric, to compacted depth of not less than 4 inches.

D. Install drainage piping as indicated on the Plans and Details

E. Add more crushed clean stone in 6 inch lifts and compact as shown on the Plans and Details

F. Repeat procedure until stone reaches designed depth as shown on the Plans and Details Wrap pipe and crushed stone with filter fabric. Overlap the filter fabric at least 12 inches.

G. Fill to Sub-grade: Install base and pave or landscape over compacted drainage course as shown on the Plans and Details.

3.5 PIPE JOINT CONSTRUCTION

A. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.

B. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.

C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.6 CLEANOUT INSTALLATION (if require)

A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

B. If require install Cleanouts:
   1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
   2. In non-vehicular-traffic areas, use NPS 4 PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, as shown on the plans and details. Set top of cleanout 1 inch above grade.
   3. Comply with requirements for concrete specified in Section 03300 "Cast-in-Place Concrete."

3.7 CONNECTIONS

A. Connect low elevations of sub-drainage system to solid-wall-piping storm drainage system.

3.8 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earth Moving."
   1. Install detectable warning tape over piping.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
   2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

3.11 AS-BUILT

A. Final As-built of all underground structure and piping lines location and elevations to be prepared by a CT Licensed surveyor and issued in paper, Mylar and AutoCad format, signed and sealed accuracy class A-2/T-2 for owner and engineer.

B. Final As-built of all items location and elevations .dwg file in AutoCAD Civil 3D format of as built prepared by a CT Licensed Land Surveyor with Civil 3D pipe networks.

END OF SECTION 33 46 00

SECTION 337102 – UNDERGROUND ELECTRICAL DISTRIBUTION

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. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
   2. Handholes and boxes.
   3. Manholes.
   4. Underground distribution cabling and grounding.

1.3 REFERENCES

A. AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
   1. AASHTO HB-17(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges
   2. AASHTO M 198(2010) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

B. AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)
   1. ACI 318M(2011; Errata 2011; Errata 2012) Building Code Requirements for Structural Concrete & Commentary
   2. ACI SP-66(2004) ACI Detailing Manual

C. ASTM INTERNATIONAL (ASTM)
   1. ASTM B(2012) Standard Specification for Hard-Drawn Copper Wire
   2. ASTM B3(2012) Standard Specification for Soft or Annealed Copper Wire
   3. ASTM B496(2004; E 2010; R 2010) Standard
   4. Specification for Compact Round Concentric-Lay-Stranded Copper Conductors
   5. ASTM B8(2011) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
   6. ASTM B800(2005; R 2011) Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers
   7. ASTM B801(2007; R 2012) Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation
   8. ASTM C13(2011) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
   9. ASTM C309(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

10. ASTM C32(2011) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
11. ASTM C478(2012a) Standard Specification for Precast Reinforced Concrete Manhole Sections
12. ASTM C857(2013) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
13. ASTM F512(2012) Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

D. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
1. IEEE 100(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
2. IEEE 400.2(2004) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
3. IEEE 81(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
4. IEEE C2(2012; Errata 2012; INT 1-4 2012) National

E. Electrical Safety Code INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)
1. NETA ATS(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

F. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
1. ANSI C119.1(2011) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
2. ANSI/NEMA WC 71/ICEA S-96-659 (1999) Standard for Nonshielded Cables
3. Rated 2001-5000 Volts for use in the Distribution of Electric Energy
4. NEMA RN 1(2005) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
5. NEMA TC 2(2003) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
6. NEMA TC 6 & 8(2003) Standard for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
7. NEMA TC 9(2004) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation

G. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
1. NFPA 7(2011; Errata 2 2012) National Electrical Code

H. UNDERWRITERS LABORATORIES (UL)
1. UL 1072(2006; Reprint Oct 2012) Medium-Voltage Power Cables
2. UL 1242(2006; Reprint Jul 2012) Standard for Electrical Intermediate Metal Conduit Steel
3. UL 467(2007) Grounding and Bonding Equipment
4. UL 486A-486B(2013) Wire Connectors
5. UL 510(2005; Reprint Apr 2008) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
6. UL 514A(2013) Metallic Outlet Boxes
7. UL 514B(2012) Conduit, Tubing and Cable Fittings
8. UL 6(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
9. UL 651(2011; Reprint Mar 2012) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
10. UL 651A(2011) Type EB and A Rigid PVC Conduit and HDPE Conduit
11. UL 83(2008) Thermoplastic-Insulated Wires and Cables
12. UL 854(2004; Reprint Sep 2011) Standard for Service-Entrance Cables

1.4 DEFINITIONS

A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

B. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

C. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

1.5 ACTION SUBMITTALS

A. Product Data: For each product, accessory as indicated.
1. Medium voltage cable;
2. Medium voltage cable joints;
3. Medium voltage cable terminations;
4. Live end caps;
5. Precast concrete structures;
6. Sealing Material
7. Pulling-In Irons
8. Manhole frames and covers;
9. Handhole frames and covers;
10. Ductile Iron Frames and Covers
11. Composite/fiberglass handholes;
12. Cable supports (racks, arms and insulators);

B. Shop Drawings
1. Precast underground structures;

C. Test Reports
1. Arc-proofing test for cable fireproofing materials; G
2. Medium voltage cable qualification and production tests; G
3. Field Acceptance Checks and Tests; G
4. Arc-proofing test for cable fireproofing tape; G
5. Cable Installation Plan and Procedure
   a. Site layout drawing with cable pulls numerically identified.
   b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.
   c. The cable manufacturer and type of cable.
   d. The dates of cable pulls, time of day, and ambient temperature.
   e. The length of cable pull and calculated cable pulling tensions.
   f. The actual cable pulling tensions encountered during pull.

1.6 QUALITY ASSURANCE

A. Precast Underground Structures: Submittal required for each type used.
1. Provide calculations and drawings for precast manholes and handholes bearing the seal of a registered professional engineer including:
   a. Material description (i.e., f'c and Fy)
   b. Manufacturer's printed assembly and installation instructions
   c. Design calculations

d. Reinforcing shop drawings in accordance with ACI SP-66
e. Plans and elevations showing opening and pulling-in iron locations and details

B. Certificate of Competency for Cable Splicer/Terminator The cable splicer/terminator must have a certification from the National Cable Splicing Certification Board (NCSCB) in the field of splicing and terminating shielded medium voltage (5 kV to 35 kV) power cable using pre-manufactured kits (pre-molded, heat-shrink, cold shrink).

C. Cable Installer Qualifications Provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations.

D. Regulatory Requirements
1. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
2. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer.
3. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

E. Standard Products
1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship.
2. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
3. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

F. Material and Equipment Manufacturing Date: Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

PART 2 - PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. Intermediate Metal Conduit UL 1242.Intermediate Metal Conduit,

C. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

D. Plastic Conduit for Direct Burial: NEMA TC 2, EPC-80-PVC.

E. Plastic Duct for Concrete Encasement: NEMA TC 6 & 8 and ASTM F512, UL 651A Type EPC-20-PVC.

2.2 CONDUIT SEALING COMPOUND

A. Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air.

B. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals.

C. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients.

D. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

2.3 FITTINGS

A. Metal Fittings: UL 514B.

B. PVC Conduit Fittings: UL 514B, UL 651.

C. PVC Duct Fittings: NEMA TC 9.

D. Outlet Boxes for Steel Conduit: Outlet boxes for use with rigid or flexible steel conduit shall be cast-metal cadmium or zinc-coated if of ferrous metal with gasketed closures and shall conform to UL 514A.

2.4 LOW VOLTAGE INSULATED CONDUCTORS AND CABLES

A. Insulated conductors shall be rated 600 volts and conform to the requirements of NFPA 70, including listing requirements. Wires and cables manufactured more than 12 months prior to date of delivery to the site shall not be accepted. Service entrance conductors shall conform to UL 854, type USE.

B. Conductor Types Cable and duct sizes indicated are for copper conductors and THHN/THWN unless otherwise noted.
   1. Conductors No.10 AWG and smaller shall be solid copper.
   2. Conductors No. 8 AWG and larger shall be stranded copper.

C. Conductor Material Unless specified or indicated otherwise or required by NFPA 70, wires in conduit, other than service entrance, shall be 600-volt, Type THWN/THHN conforming to UL 83. Copper conductors shall be annealed copper complying with ASTM B3 and ASTM B8.

D. Jackets: Multiconductor cables shall have an overall PVC outer jacket.

E. Direct Buried: Single-conductor cables shall be of a type identified for direct burial.

2.5 CABLE MARKING

A. Insulated conductors shall have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout the cable length.

B. Each cable shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

C. Conductors shall be color coded. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made.

D. Conductor identification shall be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, heat shrink type sleeves ,or colored electrical tape. Control circuit terminations shall be properly identified. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals shall be white with a different colored (not green) stripe for each.

E. Color of ungrounded conductors in different voltage systems shall be as follows
   1. 208/120 volt, three-phase
      a. Phase A - black
      b. Phase B - red
      c. Phase C - blue
   2. 480/277 volt, three-phase
      a. Phase A - brown
      b. Phase B - orange
      c. Phase C - yellow
   3. 120/240 volt, single phase: Black and red

2.6 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS

A. Shall provide a uniform compression over the entire conductor contact surface. Use solderless terminal lugs on stranded conductors.
   1. For use with copper conductors: UL 486A-486B.

2.7 LOW VOLTAGE SPLICES:

A. Provide splices in conductors with a compression connector on the conductor and by insulating and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply ANSI C119.1.
   1. Heat Shrinkable Splice: Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material which shall be applied in accordance with the manufacturer's written instructions.
   2. Cold Shrink Rubber Splice: Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation.
      a. The installation shall not require heat or flame, or any additional materials such as covering or adhesive.
      b. It shall be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

2.8 MEDIUM VOLTAGE CABLE

A. Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors shall have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length. Wires and cables manufactured more than 12 months prior to date of delivery to the site shall not be accepted. Provide single conductor type cables unless otherwise indicated.
   1. Cable Configuration: Provide Type MV cable, conforming to NEMA WC 74/ICEA S-93-639 and UL 1072. Provide cables manufactured for use in duct applications. Cable shall be rated as indicated with 133 percent insulation level.
   2. Conductor Material: Provide concentric-lay-stranded, Class B conductors. Provide soft drawn copper cables complying with ASTM B3 and ASTM B8 for regular concentric and compressed stranding or ASTM B496 for compact stranding.
   3. Insulation: Provide ethylene-propylene-rubber (EPR) insulation conforming to the requirements of ANSI/NEMA WC 71/ICEA S-96-659 and ICEA S-94-649.
   4. Shielding: Cables rated for 2 kV and above shall have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape shield for each phase.
   5. Neutrals: Neutral conductors of shall be copper, employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable.
   6. Jackets: Cables shall be provided with a PVC jacket. Direct buried cables shall be rated for direct burial. Provide PVC jackets with a separator that prevents contact when underlying semiconducting insulating shield.

2.9 MEDIUM VOLTAGE CABLE TERMINATIONS

A. IEEE 48 Class 1; of the molded elastomer, pre-stretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer.
   1. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor.
   2. Terminations shall be provided in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation.
   3. Terminations shall be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated.
   4. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

B. Cold-Shrink Type: Terminator shall be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination shall not require heat or flame for installation.
   1. Termination kit shall contain all necessary materials (except for the lugs).
   2. Termination shall be designed for installation in low or highly contaminated indoor and outdoor locations and shall resist ultraviolet rays and oxidative decomposition.

C. Heat Shrinkable Type: Terminator shall consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is nontracking, resists heavy atmospheric contaminants, ultra violet rays and oxidative decomposition.
   1. Provide heat shrinkable sheds or skirts of the same material.
   2. Termination shall be designed for installation in low or highly contaminated indoor or outdoor locations.

2.10 MEDIUM VOLTAGE CABLE JOINTS

A. Provide joints (splices) in accordance with IEEE 404 suitable for the rated voltage, insulation level, insulation type, and construction of the cable.
   1. Joints shall be certified by the manufacturer for waterproof, submersible applications.
   2. Upon request, supply manufacturer's design qualification test report in accordance with IEEE 404.
   3. Connectors for joint shall be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion.

B. Heat-Shrinkable Joint: Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding.
   1. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating.

C. Cold-Shrink Rubber-Type Joint: Joint shall be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket shall be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber.
   1. Splice shall be packaged three splices per kit, including complete installation instructions.

2.11 LIVE END CAPS

A. Provide live end caps using a "kit" including a heat-shrinkable tube and a high dielectric strength, polymeric plug overlapping the conductor. End cap shall conform to applicable portions of IEEE 48.

2.12 TAPE

A. Insulating Tape: UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

B. Buried Warning and Identification Tape: Provide detectable tape in accordance with Section 31 00 00 EARTHWORK

C. Fireproofing Tape: Provide tape composed of a flexible conformable unsupported intumescent elastomer.
   1. Tape shall be not less than .030-inch thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, and shall not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

2.13 PULL ROPE

A. Shall be plastic or flat pull line (bull line) having a minimum tensile strength of 200 pounds.

2.14 GROUNDING AND BONDING

A. System Description: 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. Comply with UL 467 for grounding and bonding materials and equipment

C. Driven Ground Rods: Provide copper-clad steel ground rods conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length.
   1. Sectional type rods may be used for rods 20 feet or longer.

D. Grounding Conductors: Stranded-bare copper conductors shall conform to ASTM B8, Class B, soft-drawn unless otherwise indicated.
   1. Solid-bare copper conductors shall conform to ASTM B1 for sizes No. 8 and smaller.
   2. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts.
   3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
   4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
   6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
   7. Aluminum is not acceptable.

E. Connectors
   1. 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.
   2. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
   3. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.15 CAST-IN-PLACE CONCRETE

A. Provide concrete in accordance with Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE.

B. In addition, provide concrete for encasement of underground ducts with 3000 psi minimum 28-day compressive strength.

C. Concrete associated with electrical work for other than encasement of underground ducts shall be 4000 psi minimum 28-day compressive strength unless specified otherwise.

2.16 HANDHOLES AND BOXES

A. Description: Comply with SCTE 77.
   1. Tier 22 rated.
   2. Color: Gray.
   3. Configuration: Units shall be designed for flush burial and have **open** bottom, unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected 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 (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and 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.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Highline Products
   b. Quazite, Hubbell Power Systems.
   c. United Illumination Shop approved equal.
2. Cover Legend: Cast in, selected to suit system.
   a. Legend: "ELECTRIC" for duct systems with power wires and cables for systems operating at 600 V and less.
   b. Legend: "ELECTRIC" for duct systems with medium-voltage cables.
   c. Legend: "SIGNAL" for communications, data, and telephone duct systems.

2.17 PRECAST CONCRETE UNDERGROUND STRUCTURES

A. Provide precast concrete underground structures and manhole types as indicated, conforming to ASTM C857 and ASTM C478.
1. Top, walls, and bottom shall consist of reinforced concrete.
2. Walls and bottom shall be of monolithic concrete construction.
3. Locate duct entrances and windows near the corners of structures to facilitate cable racking.
4. Covers shall fit the frames without undue play.
5. Form steel and iron to shape and size with sharp lines and angles.
6. Castings shall be free from warp and blow holes that may impair strength or appearance.
7. Exposed metal shall have a smooth finish and sharp lines and arises.
8. Provide necessary lugs, rabbets, and brackets.
9. Set pulling-in irons and other built-in items in place before depositing concrete.
10. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, shall be adequate to accommodate the cable.

B. General: Precast concrete structures shall have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures shall have plan area and clear heights not less than those of cast-in-place structures. Concrete materials and methods of construction shall be the same as for cast-in-place concrete construction, as modified herein.
1. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms.
2. Concrete for precast work shall have a 28-day compressive strength of not less than 4000 psi.
3. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed and produced by the manufacturer in accordance with the requirements specified.
4. Structures shall be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.

C. Design for Precast Structures: ACI 318M. In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:
1. Angle of Internal Friction (phi) =30 degrees
2. Unit Weight of Soil (Dry) =110 pcf,
3. (Saturated)=130 pcf
4. Coefficient of Lateral Earth Pressure (Ka) = 0.33
5. Ground Water Level = 3 feet below ground elevation

6. Vertical design loads shall include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact. Live loads shall consider all types and magnitudes of vehicular (automotive, industrial, or aircraft) traffic to be encountered.
7. The minimum design vertical load shall be for H20 highway loading per AASHTO HB-17.
8. Horizontal design loads shall include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, shall be considered, along with a pulling-in iron design load of 6000 pounds.
9. Each structural component shall be designed for the load combination and positioning resulting in the maximum shear and moment for that particular component.
10. Design shall also consider the live loads induced in the handling, installation, and backfilling of the manholes. Provide lifting devices to ensure structural integrity during handling and installation.

D. Construction: Structure top, bottom, and wall shall be of a uniform thickness of not less than 6 inches.
1. Thin-walled knock-out panels for designed or future duct bank entrances shall not be permitted. Quantity, size, and location of duct bank entrance windows shall be as directed, and cast completely open by the pre-caster.
2. Size of windows shall exceed the nominal duct bank envelope dimensions by at least 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows shall be a minimum of 6 inches from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope.
3. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings.
4. Provide drain sumps a minimum of 12 inches in diameter and 4 inches deep for precast structures.

E. Joints: Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer.Seal joints watertight using preformed plastic strip conforming to AASHTO M 198, Type B.
1. Install sealing material in strict accordance with the sealant manufacturer's printed instructions.
2. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

F. Manhole Frames and Covers: Provide cast iron frames and covers for manholes conforming to CID A-A-60005. Cast the words "ELECTRIC" or "TELECOMMUNICATIONS" in the top face of power and telecommunications manhole covers, respectively.

G. Frames and Covers: Frames and covers of steel shall be welded by qualified welders in accordance with standard commercial practice. Steel covers shall be rolled-steel floor plate having an approved ant slip surface. Hinges shall be of stainless steel with bronze hinge pin, 5 by 5-inches by approximately 3/16-inch thick, without screw holes, and shall be for full surface application by fillet welding. Hinges shall have nonremovable pins and five knuckles. The surfaces of plates under hinges shall be true after the removal of raised ant slip surface, by grinding or other approved method.

H. Brick for Manhole Collar: Brick shall be sewer and manhole brick conforming to ASTM C32, Grade MS.

I. Composite/Fiberglass Handholes and Covers: Provide handholes and covers of polymer concrete, reinforced with heavy weave fiberglass.

2.18 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

A. The metal portion of racks and arms shall be zinc-coated after fabrication.

B. Cable Racks: The wall bracket shall be 4 inches by approximately 1-1/2-inch by 3/16-inch channel steel, 48 inches long (minimum) in manholes. Slots for mounting cable rack arms shall be spaced at 8 inch intervals.

C. Rack Arms: Cable rack arms shall be steel or malleable iron or glass reinforced nylon and shall be of the removable type. Rack arm length shall be a minimum of 8 inches and a maximum of 12 inches.

D. Insulators: Insulators for metal rack arms shall be dry-process glazed porcelain. Insulators are not required for nylon arms.

2.19 CABLE TAGS IN MANHOLES

A. Provide tags for each power cable located in manholes. The tags shall be polyethylene. Do not provide handwritten letters. The first position on the power cable tag shall denote the voltage. The second through sixth positions on the tag shall identify the circuit. The next to last position shall denote the phase of the circuit and shall include the Greek "phi" symbol. The last position shall denote the cable size. As an example, a tag could have the following designation:"11.5 NAS 1-8(Phase A)500," denoting that the tagged cable is on the 11.5kV system circuit number NAS 1-8, underground, Phase A, sized at 500 kcmil.

B. Polyethylene Cable Tags: Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08-inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties shall have a minimum loop tensile strength of 175 pounds. The cable tags shall have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags' orientation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable. In addition to these requirements, install telecommunications in accordance with TIA-758 and RUS Bull 1751F-644.

3.2 CABLE INSPECTION

A. Prior to installation, each cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable prior to installation in accordance with the cable manufacturer's recommendations.

3.3 CABLE INSTALLATION PLAN AND PROCEDURE

A. The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature limits for installation, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, maximum allowable pulling tension, and maximum allowable sidewall bearing pressure. The Contractor shall then prepare a checklist of significant requirements which shall be submitted along with the manufacturer's instructions in accordance with SUBMITTALS. Cable shall be installed strictly in accordance with the cable manufacturer's recommendations and the approved installation plan.

3.4 UNDERGROUND STRUCTURE CONSTRUCTION

A. Provide standard type cast-in-place construction as specified herein and as indicated, or precast construction as specified herein.
   1. Horizontal concrete surfaces of floors shall have a smooth trowel finish.
   2. Cure concrete by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured.
   3. Curing compound shall conform to ASTM C309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing.
   4. Covers for underground structures shall fit the frames without undue play.
   5. Steel and iron shall be formed to shape and size with sharp lines and angles.
   6. Castings shall be free from warp and blow holes that may impair strength or appearance.
   7. Exposed metal shall have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete.

B. Precast Concrete Construction: Set commercial precast structures on 6 inches of level, 90 percent compacted granular fill, 3/4 inch to 1 inch size, extending 12 inches beyond the structure on each side.
   1. Compact granular fill by a minimum of four passes with a plate type vibrator.
   2. Installation shall additionally conform to the manufacturer's instructions.

C. Cable Racks, Arms and Insulators: Cable racks, arms and insulators shall be sufficient to accommodate the cables. Racks in power manholes shall be spaced not more than 3 feet apart, and each manhole wall shall be provided with a minimum of two racks. Racks in signal manholes shall be spaced not more than 16 1/2 inches apart with the end rack being no further than 12 inches from the adjacent wall. Methods of anchoring cable racks shall be as follows:
   1. Provide a 5/8-inch diameter by 5-inch long anchor bolt with 3-inch foot cast in structure wall with 2-inch protrusion of threaded portion of bolt into structure. Provide 5/8-inch steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.
   2. Provide concrete channel insert with a minimum load rating of 800 pounds per foot. Insert channel shall be steel of the same length as "vertical rack channel;" channel insert shall be cast flush in structure wall. Provide 5/8-inch steel nuts in channel insert to receive 5/8-inch diameter by 3-inch long steel, square head anchor bolts.
   3. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert shall have minimum 800 pound load rating. Provide 5/8-inch diameter by 3-inch long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

D. Field Painting: Cast-iron frames and covers not buried in concrete or masonry shall be cleaned of mortar, rust, grease, dirt and other deleterious materials, and given a coat of bituminous paint.

3.5 UNDERGROUND STRUCTURE/ENCLOSURE APPLICATION

A. Handholes and 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, Non-deliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20; Polymer concrete, SCTE 77, Tier 15 structural load rating.
   3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10, Polymer concrete units, SCTE 77, Tier 8 structural load rating.

B. Manholes
   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.

3.6 UNDERGROUND CONDUIT AND DUCT SYSTEMS

A. Requirements: Depths to top of the conduit shall be in accordance with NFPA 70. Run conduit in straight lines except where a change of direction is necessary. Numbers and sizes of ducts shall be as indicated.
   1. Ducts shall have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of 4 inches per 100 feet.
   2. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes.
   3. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable.
   4. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3-inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically.
   5. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used.
   6. Ducts shall be provided with end bells whenever duct lines terminate in structures.

B. Treatment: Ducts shall be kept clean of concrete, dirt, or foreign substances during construction.
   1. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape.
   2. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances.
   3. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

C. Conduit Cleaning: As each conduit run is completed, for conduit sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes, less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

D. Galvanized Conduit Concrete Penetrations: Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations shall be PVC coated and shall extend from at least 2 inches within the concrete to the first coupling or fitting outside the concrete (minimum of 6 inches from penetration).

E. Multiple Conduits: Separate multiple conduits by a minimum distance of 2 1/2 inches, except that light and power conduits shall be separated from control, signal, and telephone conduits by a minimum distance of 12 inches.
   1. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly.
   2. Provide plastic duct spacers that interlock vertically and horizontally.
   3. Spacer assembly shall consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly.
   4. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 10 feet of conduit assembly.

F. Conduit Plugs and Pull Rope: New conduit indicated as being unused or empty shall be provided with plugs on each end.
   1. Plugs shall contain a weephole or screen to allow water drainage.
   2. Provide a plastic pull rope having 3 feet of slack at each end of unused or empty conduits.

G. Conduit and Duct Without Concrete Encasement: Provide not less than 3-inches clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 1/4-inch sieve. The first 6-inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 3 to 6 inch layers. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

H. Encasement Under Roads and Structures: Under roads, paved areas, and railroad tracks, install conduits in concrete encasement of rectangular cross-section providing a minimum of 3 inch concrete cover around ducts. Concrete encasement shall extend at least 5 feet beyond the edges of paved areas and roads, and 12 feet beyond the rails on each side of railroad tracks.

I. Duct Encased in Concrete: Construct underground duct lines of individual conduits encased in concrete.
   1. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 3 inches of concrete cover for ducts.
   2. Separate conduits by a minimum concrete thickness of 2 1/2 inches, except separate light and power conduits from control, signal, and telecommunications conduits by a minimum concrete thickness of 3 inches.
   3. Before pouring concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete pouring. Anchoring shall be done by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly.
   4. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK

J. Connections to Manholes: Duct bank envelopes connecting to underground structures shall be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength.
   1. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 12 inches in each direction.
   2. Perimeter of the duct bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use

vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

K. Partially Completed Duct Banks: During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately one foot apart. Restrain reinforcing assembly from moving during concrete pouring.

3.7 CABLE PULLING

A. Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures. Cable with tape shield shall have a bending radius not less than 12 times the overall diameter of the completed cable. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

B. Cable Lubricants: Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

3.8 CABLES IN UNDERGROUND STRUCTURES

A. Do not install cables utilizing the shortest path between penetrations, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure.

B. Cable Tag Installation: Install cable tags in each manhole as specified, including each splice. Tag wire and cable provided by this contract. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes.

3.9 CONDUCTORS INSTALLED IN PARALLEL

A. Conductors shall be grouped such that each conduit of a parallel run contains 1 Phase A conductor, 1 Phase B conductor, 1 Phase C conductor, and 1 neutral conductor.

3.10 LOW VOLTAGE CABLE SPLICING AND TERMINATING

A. Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after

the splicing material has completely set. Make splices in underground distribution systems only in accessible locations such as manholes, handholes, or aboveground termination cabinets.

3.11 MEDIUM VOLTAGE CABLE TERMINATIONS

A. Make terminations in accordance with the written instruction of the termination kit manufacturer.

3.12 MEDIUM VOLTAGE CABLE JOINTS

A. Provide power cable joints (splices) suitable for continuous immersion in water. Make joints only in accessible locations in manholes or handholes by using materials and methods in accordance with the written instructions of the joint kit manufacturer.

B. Joints in Shielded Cables: Cover the joined area with metallic tape, or material like the original cable shield and connect it to the cable shield on each side of the splice. Provide a bare copper ground connection brought out in a watertight manner and grounded to the manhole grounding loop as part of the splice installation. Ground conductors, connections, and rods shall be as specified elsewhere in this section. Wire shall be trained to the sides of the enclosure to prevent interference with the working area.

3.13 CABLE END CAPS

A. Cable ends shall be sealed at all times with coated heat shrinkable end caps. Cables ends shall be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps shall remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

3.14 LIVE END CAPS

A. Provide live end caps for single conductor medium voltage cables where indicated.

3.15 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES

A. Fireproof (arc proof) wire and cables which will carry current at 2200 volts or more in underground structures.

B. Fireproofing Tape: Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Install tape in accordance with manufacturer's instructions.

C. Tape-Wrap: Tape-wrap metallic-sheathed or metallic armored cables without a nonmetallic protective covering over the sheath or armor prior to application of fireproofing. Wrap shall be in the form of two tightly applied half-lapped layers of a pressure-sensitive 10 mil thick plastic tape, and shall extend not less than one inch into the duct. Even out irregularities of the cable, such as at splices, with insulation putty before applying tape.

3.16 GROUNDING SYSTEMS

A. Provide grounding system as indicated, in accordance with NFPA 70 and IEEE C2, and as specified herein.
   1. Exterior Lighting Circuits
   2. Underground electric distribution conduit.
   3. Exterior lighting poles.
   4. Exterior lighting luminaires.

B. Noncurrent-carrying metallic parts associated with electrical equipment shall have a maximum resistance to solid earth ground not exceeding the following values:
   1. Pad-mounted transformers: 5 ohms
   2. Ground In manholes: 5 ohms
   3. Grounding other metal enclosures of primary voltage electrical and electrically operated equipment: 5 ohms

C. Grounding Electrodes
   1. Provide cone pointed driven ground rods driven full depth plus 12 inches, installed to provide an earth ground of the appropriate value for the particular equipment being grounded.
   2. If the specified ground resistance is not met, an additional ground rod shall be provided in accordance with the requirements of NFPA 70 (placed not less than 6 feet from the first rod).
   3. Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

D. Grounding Connections: Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.
   1. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.
   2. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

E. Grounding Conductors: Provide bare grounding conductors, except where installed in conduit with associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with No. 6 AWG. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 6 AWG. Provide direct connections to the grounding conductor with 600 v insulated, full-size conductor for each grounded neutral of each feeder circuit, which is spliced within the manhole.

F. Ground Cable Crossing Expansion Joints: Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

G. Manhole Grounding: Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 12 inches above finished floor. Secure the conductor to the manhole walls at intervals not exceeding 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 6 AWG conductor.

H. 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.

I. Pad-Mounted Transformers and Switches: Install two ground rods and 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 (150 mm) from the foundation.

J. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation

3.17 EXCAVATING, BACKFILLING, AND COMPACTING

A. Provide in accordance with NFPA 70 and Section 31 00 00 EARTHWORK.

B. Reconditioning of Surfaces
1. Unpaved Surfaces: Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding, and provide top-soiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.
2. Paving Repairs: Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists, restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.

3.18 CAST-IN-PLACE CONCRETE

A. Provide concrete in accordance with Section .03 30 00 CAST-IN-PLACE CONCRETE

B. Concrete Slabs for Equipment: Unless otherwise indicated, the slab shall be at least 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 4 inches from the top of the slab.
1. Slab shall be placed on a 6-inch thick, well-compacted gravel base.
2. Top of concrete slab shall be approximately 4-inches above finished grade with gradual slope for drainage.
3. Edges above grade shall have 1/2-inch chamfer.
4. Slab shall be of adequate size to project at least 8 inches beyond the equipment.
5. Stub up conduits, with bushings, 2-inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

C. Sealing: When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.19 FIELD QUALITY CONTROL

A. Performance of Field Acceptance Checks and Tests: Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

B. Medium Voltage Cables: Perform tests after installation of cable, splices, and terminators and before terminating to equipment or splicing to existing circuits.
   1. Visual and Mechanical Inspection
      a. Inspect exposed cable sections for physical damage.
      b. Verify that cable is supplied and connected in accordance with contract plans and specifications.
      c. Inspect for proper shield grounding, cable support, and cable termination.
      d. Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.
      e. Inspect for proper fireproofing.
      f. Visually inspect jacket and insulation condition.
      g. Inspect for proper phase identification and arrangement.
   2. Electrical Tests
      a. Perform a shield continuity test on each power cable by ohmmeter method. Record ohmic value, resistance values in excess of 10 ohms per 1000 feet of cable must be investigated and justified.
      b. Perform acceptance test on new cables before the new cables are connected to existing cables and placed into service, including terminations and joints. Perform maintenance test on complete cable system after the new cables are connected to existing cables and placed into service, including existing cable, terminations, and joints. Tests shall be very low frequency (VLF) alternating voltage withstand tests in accordance with IEEE 400.2. VLF test frequency shall be 0.05 Hz minimum for a duration of 60 minutes using a sinusoidal waveform. Test voltages shall be as follows:

CABLE RATING AC TEST VOLTAGE for ACCEPTANCE TESTING	
5 kV	10kV rms(peak)
8 kV	13kV rms(peak)
15 kV	20kV rms(peak)
25 kV	31kV rms(peak)
35 kV	44kV rms(peak)

CABLE RATING AC TEST VOLTAGE for MAINTENANCE TESTING	
5 kV	7kV rms(peak)
8 kV	10kV rms(peak)
15 kV	16kV rms(peak)

25 kV	23kV rms(peak)
35 kV	33kV rms(peak)

C. Grounding System
   1. Visual and mechanical inspection: Inspect ground system for compliance with contract plans and specifications
   2. Electrical tests
      a. Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected.
      b. Take measurements in normally dry weather, not less than 48 hours after rainfall.Use a portable megohmmeter tester in accordance with manufacturer's instructions to test each ground or group of grounds.The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

3.20 AS-BUILT

A. Final As-built of all items location and elevations prepared by a CT Licensed Land Surveyor in paper, Mylar and AutoCad format signed and sealed accuracy class A-2/T-2 for owner and engineer.

B. Final As-built of all items location and elevations .dwg file in AutoCAD Civil 3D format of as built prepared by a CT Licensed Land Surveyor with Civil 3D pipe networks.

END OF SECTION

SECTION 337119 - ELECTRICAL UNDERGROUND DUCTS AND HANDHOLES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rigid steel conduit.
2. Plastic conduit.
3. Plastic duct.
4. Reinforced resin conduit.
5. Precast concrete manholes.
6. Handholes.
7. Underground duct markers.
8. Cast-in-place manhole accessories.

B. Related Sections:
1. Section 31 23 16 - Excavation: Product and execution requirements for excavation and backfill required by this section.
2. Section 31 23 33 - Trenching: Execution requirements for trenching required by this section.
3. Section 31 23 33 - Fill: Requirements for backfill to be placed by this section.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

B. ASTM International:
1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
2. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
3. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
4. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
5. ASTM C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures.

C. Institute of Electrical and Electronics Engineers:
1. IEEE C2 - National Electrical Safety Code.

D. National Electrical Manufacturers Association:
1. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
2. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
3. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
4. NEMA TC 6 - PVC and ABS Plastic Utilities Duct for Underground Installation.
5. NEMA TC 9 - Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
6. NEMA TC 10 - PVC and ABS Plastic Communications Duct for Underground Installation.
7. NEMA TC 14 - Filament Wound Reinforced Thermosetting Resin Conduit and Fittings.

E. Underwriters Laboratories Inc.:
   1. UL 651A - Type EB and A Rigid PVC Conduit and HDPE Conduit.

1.3 SYSTEM DESCRIPTION

A. Interconnected system of encased conduits, ducts, manholes and handholes to distribute medium-voltage power, telephone, data communications, exterior branch circuit wiring, and exterior lighting branch circuit wiring.

B. Conduit and duct routing and handhole locations are shown in approximate locations unless dimensions are indicated. Route and locate to complete duct bank system.

C. Ducts and conduits routed to the future building site shall be terminated 5’-0” from the building foundation line. All ducts terminated in this fashion shall be capped and provided with nylon drag lines

D. Medium-voltage: Comply with Utility Company requirements for primary service ducts and conduits.

E. Exterior branch circuit and lighting: Use rigid plastic underground conduit. Provide rigid steel conduit sweeps up into bases and structures.

F. Telephone: Comply with Utility Company requirements for primary service ducts and conduits.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit for metallic conduit, nonmetallic conduit, ducts, and handholes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 SUSTAINABLE DESIGN SUBMITTALS

A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design submittals.

B. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.
   1. Materials Resources Certificates:
      a. Certify source and origin for salvaged and reused products.
      b. Certify recycled material content for recycled content products.
      c. Certify source for local and regional materials and distance from Project site.

C. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.
   1. Provide cost data for the following products:
      a. Salvaged products.
      b. Reused products.

c. Products with recycled material content.
d. Local and regional products.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of handholes.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

1.8 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work with existing underground utilities and structures.

PART 2 PRODUCTS

2.1 RIGID STEEL CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Rigid Steel Conduit: ANSI C80.1.

C. Rigid Aluminum Conduit: ANSI C80.5.

D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 PLASTIC CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Allied Tube and Conduit.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Fittings and Conduit Bodies: NEMA TC 3.

C. Rigid Plastic Conduit: NEMA TC 2, Schedule 40/80 PVC, with fittings and conduit bodies to NEMA TC 3.

2.3 HANDHOLES

A. In-Ground Handholes: Stackable 18”x16”x12”, open bottom as manufactured by Qauzite Co.:
   1. Material: Precast concrete.
   2. Cover: Traffic rated precast concrete.
   3. Cover Legend: "ELECTRIC" or “TELEPHONE”.
   4. Provide size as required for primary electrical and telco circuits.

B. Description: Molded composite handhole comprising modular, interlocking sections complete with accessories.

C. Loading: ASTM C857, Class A-16.

D. Covers: Molded composite with tamperproof fasteners. Furnish cover marked to indicate utility.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify routing and termination locations of duct bank prior to excavation for rough-in.

C. Verify locations of handholes prior to excavating for installation.

3.2 INSTALLATION

A. Install Work in accordance with the requirements of the Town of Enfield and the State of Connecticut DOT.standards.

3.3 INSTALLATION - DUCT BANK

A. Install duct to locate top of ducts at depths as indicated on Drawings.

B. Install conduit and duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope conduit and duct toward manholes and away from building entrances.

C. Cut conduit and duct square using saw or pipe cutter; de-burr cut ends.

D. Insert conduit and duct to shoulder of fittings; fasten securely.

E. Join nonmetallic conduit and duct using adhesive as recommended by manufacturer.

F. Wipe nonmetallic conduit and duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

G. Install no more than equivalent of three 90-degree bends between pull points.

H. Install fittings to accommodate expansion and deflection.

I. Terminate conduit and duct at manhole entries using end bell.

J. Stagger conduit and duct joints vertically in concrete encasement 6 inches minimum.

K. Use suitable separators and chairs installed not greater than 4 feet on centers. Secure separators and chairs to trench bottom prior to concrete pour.

L. Band conduits and ducts together before backfilling or placing concrete.

M. Securely anchor conduit and duct to prevent movement during concrete placement.

N. Place concrete in accordance with Section 03 30 00.

O. Install ducts with minimum 3 inch concrete cover at bottom, top, and sides.

P. Install steel reinforcing bars in top of bank under paved areas per civil specifications and details.

Q. Connect to existing concrete encasement using dowels.

R. Connect to manhole wall using dowels.

S. Provide suitable pull string in each empty duct except sleeves and nipples.

T. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.

U. Backfill trenches in accordance with Section 31 23 33.

3.4 INSTALLATION - PRE-CAST HANDHOLE

A. Excavate for handhole installation in accordance with Section 31 23 16.

B. Install and seal precast sections in accordance with ASTM C891.

C. Install handholes plumb.

D. Backfill handhole excavation in accordance with Section 31 23 33.

END OF SECTION

SECTION 337900 - SITE GROUNDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rod electrodes.
2. Active electrodes.
3. Exothermic connections.
4. Mechanical connectors.
5. Wire.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE C2 - National Electrical Safety Code.

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SYSTEM DESCRIPTION

A. Rod electrodes for local grounding at utility transformer, generator and exterior metallic poles.

1.4 PERFORMANCE REQUIREMENTS

A. Overall Resistance to Ground: 25 ohms.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate layout and installation details of grounding components.

C. Product Data: Submit data for grounding electrodes and connectors.

D. Test Reports: Indicate overall resistance to ground.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of electrodes and connections.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

A. Manufacturers:
1. Copperweld, Inc.
2. Erico, Inc.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description:
1. Material: Copper-clad steel.
2. Diameter: 3/4 inch.
3. Length: 10 feet.

C. Connector: Connector for exothermic welded connection.

2.2 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. Cadweld, Erico, Inc.
2. Copperweld, Inc.
3. ILSCO Corporation.
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical.
6. Substitutions: Section 01 60 00 - Product Requirements

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.3 MECHANICAL CONNECTORS

A. Manufacturers:
1. Copperweld, Inc.
2. Erico, Inc.
3. ILSCO Corporation
4. O-Z Gedney Co.
5. Thomas & Betts, Electrical.
6. Substitutions: Section 01 60 00 - Product Requirements

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.4 WIRE

A. Material: Stranded copper.

B. Horizontal Electrodes: 4/0 AWG, minimum size.

C. Connections to Electrodes: 2/0 AWG, minimum size.

D. Bonding Other Objects: 2 AWG, minimum size.

E. Mechanical Connector: Bronze.

F. Grounding Boxes: Bronze.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Install rod electrodes in vertical position with bottom at least 5 feet below frost line.

B. Install interconnecting wire 2 feet below frost line.

C. Provide chemical treatment at each vertical electrode site.
   1. Saturate treatment chemicals with water following application.
   2. Dig circular trench centered on electrode. Make trench 12 inches deep with 18 inch inside diameter. Uniformly distribute 50 lb of treatment material in bottom of trench and cover with topsoil.

3.3 FIELD QUALITYCONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.13. Make final grounding system measurements three or four days after chemical treatment.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate location of each accessible grounding connection and each chemical treatment well.

END OF SECTION