ADDENDUM NO. 2 April 24, 2013
NEW DOVER HIGH SHOOL – BID PACKAGE G-1
Dover, Delaware 19904

NOTICE: Attach this addendum to the project manual for this project. It modifies and becomes a part of the contract documents. Work or materials not specifically mentioned herein are to be described in the main body of the specifications and as shown on the drawings. Bidders shall acknowledge receipt of this addendum on the space provided on the Bid Form. Failure to do so may subject the bidder to disqualification.

The contract documents for the above referenced project, dated March 1, 2013 are amended as follows:

GENERAL CLARIFICATIONS

- Bid are due on Tuesday, May 16, 2013 and will be received at the Professional Development Administration Building located at 198 Commerce Way Dover, Delaware 19904-8210 until 3:00 pm.

MODIFICATIONS TO SPECIFICATIONS

Section 00 41 00 Bid Forms and Attachments: DELETE this section in its entirety and INSERT new section attached.
Section 01 11 00 PU09 Summary of Work: DELETE this section in its entirety and INSERT new section attached.
Section 01 23 00 Alternates: DELETE this section in its entirety and INSERT new section attached.
Section 019113 General Commissioning Requirements
Section 019114 Plumbing Commissioning Requirements
Section 019116 Electrical Commissioning
Section 033000 Cast-in-Place Concrete
Section 051200 Structural Steel Framing
Section 054000 Cold-Formed Metal Framing
Section 054400 Cold-Formed Metal Trusses
Section 078413 HVAC & Plumbing Penetration Firestopping
Section 129300 Site Furnishings
Section 220500 Common Work Results for Plumbing
Section 220505 Plumbing Piping, Fittings, Valves
Section 220701 Plumbing Insulation
Section 224000 Plumbing Fixtures
Section 224005 Plumbing Equipment
Section 230500 Common Work Results for HVAC
Section 230548 Vibration Controls for HVAC, Plumbing & Fire Protection Equipment
Section 230593 Testing Adjusting & Balancing for HVAC & Plumbing
Section 230600 Heating Ventilating and Air Conditioning Equipment
Section 230900 Automatic Temperature control – Small Standalone
Section 233000 HVAC Air Distribution
Section 260500 Common Work Results for Electrical
Section 260513 Medium Voltage Cables
Section 260519 Low-Voltage Electrical Power Conductors and Cables
Section 260526 Grounding and Bonding for Electrical Systems

Section 260529 Hangers and Supports for Electrical Systems
Section 260533 Raceway and Boxes for Electrical Systems
Section 260913 Power Metering System
Section 260923 Lighting and Branch Circuit Control Devices
Section 260943 Expansion of Lutron Quantum Lighting Controls
Section 261118 Outdoor Switchgear
Section 261200 Pad-Mounted Transformers, Liquid Filled
Section 262200 Low-Voltage Transformers
Section 262416 Panelboards
Section 262716 Electrical Cabinets and Enclosures
Section 262726 Wiring Devices
Section 262819 Enclosed Switches
Section 262823 Enclosed Circuit Breakers
Section 262913 Enclosed Controllers
Section 264100 Facility Lightning Protection
Section 260500 Common Work Results for Electrical
Section 265600 Athletic Field Sports Lighting
Section 283110 Fire Alarm Expansion
Section 323113 Chain Link Fences
Section 323119 Decorative Fences and Gates
Section 329200 Meadow Planting
Section 329223 Lawns
Section 329300 Plants
Section 337119 Electrical Underground Ducts/Handholes/Pull Boxes
Section 337173 Electrical Utility Services

MODIFICATIONS TO DRAWINGS

BID PAC G – GENERAL
I G-001.G VOLUME I - BID PAC G - COVER SHEET
I G-002.G DRAWING LIST
CIVIL
C-001G COVER SHEET & OVERALL LAYOUT
C-201G SITE, SIGNAGE AND STRIPING PLAN
C-202G SITE, SIGNAGE AND STRIPING PLAN
C-203G SITE, SIGNAGE AND STRIPING PLAN
C-204G SITE, SIGNAGE AND STRIPING PLAN
C-205G SITE, SIGNAGE AND STRIPING PLAN
C-206G SITE, SIGNAGE AND STRIPING PLAN
C-300G OVERALL UTILITIES PLAN AND KEY SHEET
C-301G UTILITIES PLAN
C-302G UTILITIES PLAN
C-303G UTILITIES PLAN
C-304G UTILITIES PLAN
C-305G UTILITIES PLAN
C-306G UTILITIES PLAN

C-307G UTILITIES PLAN
C-400G OVERALL GRADING PLAN AND KEY SHEET
C-401G GRADING PLAN
C-402G GRADING PLAN
C-403G GRADING PLAN
C-404G GRADING PLAN
C-405G GRADING PLAN
C-406G GRADING PLAN
C-407G GRADING PLAN & UTILITY PLAN (ALTERNATES)
C-901G CONSTRUCTION DETAILS
C-902G CONSTRUCTION DETAILS
C-904G BASEBALL FIELD DETAILS
C-905G SOFTBALL FIELD DETAILS
C-906G FIELD STRIPING & GOAL DETAILS
C-907G FIELD STRIPING & GOAL DETAILS
C-908G ATHLETIC COURTS & EQUIPMENT DETAILS
C-909G TRACK & FIELD DETAILS (MAIN STADIUM)
C-910G AUXILARY FIELD DETAILS (BASE BID)

LANDSCAPE

L1.0 OVERALL LANDSCAPE KEY PLAN
L1.1 PLANTING SOILS & TURF TYPE LAYOUT PLAN - WEST
L1.2 PLANTING SOILS & TURF TYPE LAYOUT PLAN - EAST
L2.0 HARDSCAPE PLAN - WEST COURTYARD ENLARGEMENT
L2.1 HARDSCAPE PLAN - EAST COURTYARD ENLARGEMENT
L2.2 HARDSCAPE PLAN - STADIUM PLAZA ENLARGEMENT
L2.3 HARDSCAPE PLAN - STADIUM PLAZA ENLARGEMENT
L2.4 HARDSCAPE PLAN - VISITOR ENTRY & CONCESSIONS ENLARGEMENT
L2.5 FENCE TYPE DIAGRAM
L2.5.1 FENCE PLAN - AUXILIARY STADIUM
L2.6 HARDSCAPE LAYOUT PLAN - WEST COURTYARD & MAIN BUILDING ENTRANCE
L2.7 HARDSCAPE LAYOUT PLAN - STADIUM PLAZA
L2.8 HARDSCAPE LAYOUT PLAN - STADIUM PLAZA
L3.0 HARDSCAPE DETAILS
L3.1 HARDSCAPE DETAILS
L3.2 HARDSCAPE DETAILS
L3.3 HARDSCAPE DETAILS
L4.0 LANDSCAPE PLAN
L4.1 LANDSCAPE PLAN
L4.2 LANDSCAPE PLAN
L4.3 LANDSCAPE PLAN
L4.4 LANDSCAPE PLAN
L4.5 LANDSCAPE PLAN
L4.6 LANDSCAPE PLAN - ENLARGEMENT
L4.7 LANDSCAPE PLAN - ENLARGEMENT
L4.8 BIO-RETENTION AREA 1 PLANTING PLAN
L4.9 OVERALL MEADOW PLANTING PLAN
L4.10 PLANTING SCHEDULE & DETAILS

STRUCTURAL
SF-100 STRUCTURAL NOTES
SF-111 FOUNDATION PLAN - AREA FH (FIELDHOUSE)
SF-112 ROOF FRAMING PLAN - AREA FH (FIELDHOUSE)
SF-121 REMOTE ATHLETIC & MAINTENANCE BUILDING STRUCTURAL PLANS – ALTERNATE (not included in this addendum)
SF-131 BASEBALL FIELD DUGOUT - FOUNDATION, ROOF FRAMING PLAN & SECTIONS
SF-132 SOFTBALL FIELD DUGOUT - FOUNDATION, ROOF FRAMING PLAN & SECTIONS
SF-201 TYPICAL SECTIONS & DETAILS
SF-301 TYPICAL SECTIONS AND DETAILS
II G-001.G VOLUME II - BID PAC G - COVER SHEET
II G-002.G DRAWING LIST
ARCHITECTURAL
SP-100 SITE KEYPLAN - OVERALL
SP-101 SITE PLAN - PARTIAL
SP-102 SITE PLAN - PARTIAL
ATHLETIC FIELD
AF-001 CODE SUMMARY DIAGRAM - MAIN STADIUM
AF-002 CODE REVIEW DIAGRAMS AND SUMMARY
AF-003 PARTITION SCHEDULE
AF-101 OVERALL PLAN - MAIN AND AUXILIARY STADIA
AF-102 OVERALL PLAN - REMOTE ATHLETICS
AF-111 FLOOR PLANS
AF-112 REFLECTED CEILING PLANS
AF-113 FINISH PLANS / CASEWORK ELEVATIONS
AF-114 ROOF PLANS
AF-131 FLOOR PLAN - BASEBALL DUGOUT
AF-132 FLOOR PLAN - SOFTBALL DUGOUT
AF-211 ELEVATIONS - FIELDHOUSE - FB
AF-231 ELEVATIONS/ SECTIONS / DETAILS
AF-301 BUILDING SECTIONS
AF-302 BUILDING SECTIONS
AF-331 WALL SECTIONS
AF-332 WALL SECTIONS
AF-333 WALL SECTIONS
AF-334 WALL SECTIONS
AF-335 WALL SECTIONS
AF-336 WALL SECTIONS / EXTERIOR ELEVATIONS - ALTERNATE
AF-401 ENLARGED TOILET PLANS
AF-402 TOILET ROOM ELEVATIONS
AF-431 PLAYING FIELD DIAGRAM - MAIN STADIUM
AF-432 PLAYING FIELD DIAGRAM - AUXILIARY STADIUM
AF-450 FOOTBALL BLEACHERS (HOME) - SECTION VIEW
AF-451 FOOTBALL BLEACHERS (HOME) - SECTION VIEW RAMP & EXIT
DETAILS
AF-452 FOOTBALL BLEACHERS (VISITOR) - SECTION VIEW
AF-453 FOOTBALL BLEACHERS (HOME & VISITOR) - BASE SEATING LAYOUT

AF-454 FOOTBALL BLEACHERS (HOME & VISITOR) - BASE FOOTING

LAYOUTS

AF-455 FOOTBALL BLEACHERS (HOME & VISITOR) - ALTERNATE SEATING LAYOUTS
AF-456 FOOTBALL BLEACHERS (HOME & VISITOR) - ALTERNATE FOOTING LAYOUTS
AF-457 FOOTBALL BLEACHERS (HOME) - PRESSBOX DETAILS
AF-458 FOOTBALL BLEACHERS (VISITOR) - RAMP & EXIT DETAILS
AF-459 FOOTBALL BLEACHERS (HOME & VISITOR) - SITE PLAN
AF-460 FOOTBALL BLEACHERS (HOME) - FRONT ELEVATION VIEWS (BASE & ALTERNATE BIDS)
AF-461 BASEBALL BLEACHERS - SECTION VIEW
AF-462 BASEBALL BLEACHERS - SECTION VIEW
AF-463 BASEBALL BLEACHERS - SEATING LAYOUT
AF-464 BASEBALL BLEACHERS - FOOTING LAYOUT
AF-465 BASEBALL BLEACHERS - RAMP & EXIT DETAILS
AF-466 BASEBALL - PRESSBOX DETAILS
AF-467 SOFTBALL BLEACHERS - SECTION VIEW
AF-468 SOFTBALL BLEACHERS - SECTION VIEW
AF-469 SOFTBALL BLEACHERS - SEATING LAYOUT
AF-470 SOFTBALL BLEACHERS - FOOTING LAYOUT
AF-471 SOFTBALL BLEACHERS PRESSBOX DETAILS
AF-472 ALTERNATE - SOCCER BLEACHERS - SECTION VIEW
AF-473 ALTERNATE - SOCCER BLEACHERS - SEATING & FOOTING LAYOUT
AF-474 ALTERNATE - SOCCER BLEACHERS - RAMP & EXIT DETAILS
AF-475 ALTERNATE SOCCER PRESSBOX DETAILS
AF-476 FOOTING & GRADE BEAMS DESIGNS
AF-530 PLAN DETAILS
AF-550 VERTICAL DETAILS
AF-590 ROOF DETAILS
AF-600 DOOR SCHEDULE & DETAILS
AF-610 WINDOW SCHEDULE

PLUMBING

PF-111-D STADIUM FIELDHOUSE - NORTH WING - PLUMBING
PF-111-S STADIUM FIELDHOUSE - NORTH WING - PLUMBING
PF-112-D STADIUM FIELDHOUSE - EAST WING - PLUMBING
PF-112-S STADIUM FIELDHOUSE - EAST WING - PLUMBING
PF-113-D STADIUM FIELDHOUSE - WEST WING - PLUMBING
PF-113-S STADIUM FIELDHOUSE - WEST WING - PLUMBING
PF-115 STADIUM FIELDHOUSE - NORTH WING ROOF PLAN - PLUMBING
PF-116 STADIUM FIELDHOUSE - EAST WING ROOF PLAN - PLUMBING
PF-117 STADIUM FIELDHOUSE - WEST WING ROOF PLAN - PLUMBING
PF-301 DETAILS - PLUMBING
PF-302 DETAILS - PLUMBING
PF-303 DETAILS - PLUMBING
PF-401 SCHEDULES - PLUMBING
PF-501 RISERS PLUMBING
PF-502 RISERS PLUMBING

MECHANICAL

MF-111 STADIUM FIELDHOUSE - NORTH WING – HVAC

MF-112 STADIUM FIELDHOUSE - EAST WING - HVAC
MF-113 STADIUM FIELDHOUSE - WEST WING - HVAC
MF-201 DETAILS HVAC
MF-301 SCHEDULES HVAC

ELECTRICAL

EF-100 ELECTRICAL NOTES, SCHEDULES & LEGEND
EF-101 ELECTRICAL SITE PLAN - PARTS 1 & 2
EF-102 ELECTRICAL SITE PLAN - PART 3
EF-103 ELECTRICAL SITE DETAILS
EF-141 ELECTRICAL POWER PLANS STADIUM FIELDHOUSES BALL FIELD BUILDING MAINTENANCE BUILDING
EF-241 ELECTRICAL LIGHTING PLANSSTADIUM FIELDHOUSES BALL FIELD BUILDING MAINTENANCE BUILDING
EF-300 ELECTRICAL PLANS STADIUM BLEACHERS BASEBALL BLEACHERS SOFTBALL BLEACHERS SOCCER BLEACHERS
EF-600 ELECTRICAL SINGLE LINE DIAGRAM
EF-700 ELECTRICAL PANEL SCHEDULES
EF-701 ELECTRICAL PANEL & LIGHTING FIXTURE SCHEDULES

TECHNOLOGY

T100 TECHNOLOGY FOOTBALL STADIUM AUXILIARY SOUND SYSTEM
T200 TECHNOLOGY SOCCER STADIUM AUXILIARY SOUND SYSTEM
T300 TECHNOLOGY BASEBALL STADIUM AUXILIARY SOUND SYSTEM
T400 TECHNOLOGY SOFTBALL STADIUM AUXILIARY SOUND SYSTEM

End of Addendum No. 2

Contract NDHS-33: Site, Field, Stadiums and Accessories

BID FORM

For Bids Due: _____ To: Capital School District
945 Forest Street
Dover, Delaware 19904

Name of Bidder: _____

Bidder Address: _____

_____

Contact Name: _____ E-Mail Address: _____

Delaware Business License No.: _____ Taxpayer ID No.: _____

(Other License Nos.): _____

Phone No.: ( ) _____ - _____ Fax No.: ( ) _____ - _____

The undersigned, representing that he has read and understands the Bidding Documents and that this bid is made in accordance therewith, that he has visited the site and has familiarized himself with the local conditions under which the Work is to be performed, and that his bid is based upon the materials, systems and equipment described in the Bidding Documents without exception, hereby proposes and agrees to provide all labor, materials, plant, equipment, supplies, transport and other facilities required to execute the work described by the aforesaid documents for the lump sum itemized below:

$_____ ($_____)

ALTERNATES

Alternate BPG-25: Bermuda Grass at Practice Field (unit pricing per field).

Add/Deduct _____ ($_____)

Alternate BPG-29: Add (2) Tennis Courts.

Add/Deduct _____ ($_____)

Alternate BPG-34: Grass (Bermuda) at Auxiliary Stadium Field.

Add/Deduct _____ ($_____)

Alternate BPG-38: Add Synthetic Athletic Turf in "D" Areas of Main Stadium Field.

Add/Deduct _____ ($_____)

UNIT PRICES

N/A

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for one hundred twenty (120) days (Project Manager's Note: Verify and coordinate with Section 00 21 13 Instruction to Bidders.) from the date of opening of bids, and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid (if required).

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

_____
(State of Corporation)

Business Address: _____

_____

_____

_____

Witness: _____ By: _____

(Authorized Signature)

(SEAL)

_____

(Title)

Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement
Bid Bond
Consent of Surety
(Others as Required by Project Manuals)

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor must be listed for each category where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the Owner, it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work.

Subcontractor Category	Subcontractor	Address (City & State)
1. Sitework		
2. Landscaping		
3.		
4.		
5.		

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date _____.

All the terms and conditions of Contract NDHS-33 Site, Field, Stadiums and Accessories has been thoroughly examined and are understood.

NAME OF BIDDER: _____

AUTHORIZED REPRESENTATIVE (TYPED): _____

AUTHORIZED REPRESENTATIVE (SIGNATURE): _____

TITLE: _____

ADDRESS OF BIDDER: _____

_____

_____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

BID BOND

TO ACCOMPANY PROPOSAL
(Not necessary if security is used)

KNOW ALL MEN BY THESE PRESENTS That: _____of _____in the County of _____ and State of _____ as Principal, and _____of _____in the County of _____ _____ and State of _____ as Surety, legally authorized to do business in the State of Delaware ('State"), are held and firmly unto the Capital School District in the sum of _____ Dollars (S_____), or percent not to exceed _____ Dollars (S_____) of amount of bid on Contract No. _____ to be paid to the Capital School District for the use and benefit of the Capital School District for which payment well and truly to be made, we do bind ourselves, our and each of our heirs, executors, administrators. and successors, jointly and severally for and in the whole firmly by these presents.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH That if the above bounden Principal who has submitted to the Capital School District a certain proposal to enter into this contract for the furnishing of certain material and/or services within the State, shall be awarded this Contract, and if said Principal shall well and truly enter into and execute this Contract as may be required by the terms of this Contract and approved by the Capital School District this Contract to be entered into within twenty days after the date of official notice of the award thereof in accordance with the terms of said proposal, then this obligation shall be void or else to be and remain in full force and virtue.

Sealed with _____seal and dated this____day of _____in the year of our Lord two thousand and _____(20__).

SEALED, AND DELIVERED IN THE PRESENCE OF

_____
Name of Bidder (Organization)

Corporate Seal

By:_____
Authorized Signature

Attest _____ _____
Title

_____
Name of Surety

Witness_____ _____

_____
Title

CONSENT OF SURETY

DATE_____

To: Capital School District
945 Forest Street
Dover, Delaware 19904

Gentlemen:

We, the _____

_____
(Surety Company's Address)

_____

a Surety Company authorized to do business in the State of Delaware hereby agrees that if

_____
(Contractor)

_____
(Address)

_____

is awarded the Contract No. _____

We will write the required Performance and/or Labor and Material Bond required by Paragraph 8 of the Instructions to Bidders.

_____
(Surety Company)

By _____
(Attorney-in-Fact)

END OF SECTION

Contract NDHS-34: General Construction

BID FORM

For Bids Due: _____ To: Capital School District
945 Forest Street
Dover, Delaware 19904

Name of Bidder: _____

Bidder Address: _____

_____

Contact Name: _____ E-Mail Address: _____

Delaware Business License No.: _____ Taxpayer ID No.: _____

(Other License Nos.): _____

Phone No.: ( ) _____ - _____ Fax No.: ( ) _____ - _____

The undersigned, representing that he has read and understands the Bidding Documents and that this bid is made in accordance therewith, that he has visited the site and has familiarized himself with the local conditions under which the Work is to be performed, and that his bid is based upon the materials, systems and equipment described in the Bidding Documents without exception, hereby proposes and agrees to provide all labor, materials, plant, equipment, supplies, transport and other facilities required to execute the work described by the aforesaid documents for the lump sum itemized below:

$_____ ($_____)

ALTERNATES

Alternate BPG-26: Add Maintenance Building.

Add/Deduct _____ ($_____)

Alternate BPG-30: Add Ticket Booths and Signage Structures – Main & Auxiliary Stadium.

Add/Deduct _____ ($_____)

UNIT PRICES

N/A

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for one hundred twenty (120) days (Project Manager's Note: Verify and coordinate with Section 00 21 13 Instruction to Bidders.) from the date of opening of bids, and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid (if required).

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

_____
(State of Corporation)

Business Address:_____
_____
_____
_____

Witness: _____ By: _____
(Authorized Signature)

(SEAL)

_____
(Title)

Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement
Bid Bond
Consent of Surety
(Others as Required by Project Manuals)

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor must be listed for each category where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the Owner, it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work.

Subcontractor Category	Subcontractor	Address (City & State)
1. General Construction		
2. Masonry		
3. Electrical		
4. Mechanical		
5.		

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date _____.

All the terms and conditions of Contract NDHS-34 General Construction has been thoroughly examined and are understood.

NAME OF BIDDER: _____

AUTHORIZED REPRESENTATIVE (TYPED): _____

AUTHORIZED REPRESENTATIVE (SIGNATURE): _____

TITLE: _____

ADDRESS OF BIDDER: _____

_____

_____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

BID BOND

TO ACCOMPANY PROPOSAL
(Not necessary if security is used)

KNOW ALL MEN BY THESE PRESENTS That: _____of _____in the County of _____ and State of _____ as Principal, and _____of _____in the County of _____ _____ and State of _____ as Surety, legally authorized to do business in the State of Delaware ('State"), are held and firmly unto the Capital School District in the sum of _____ Dollars (S_____), or percent not to exceed _____ Dollars (S_____) of amount of bid on Contract No. _____ to be paid to the Capital School District for the use and benefit of the Capital School District for which payment well and truly to be made, we do bind ourselves, our and each of our heirs, executors, administrators. and successors, jointly and severally for and in the whole firmly by these presents.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH That if the above bounden Principal who has submitted to the Capital School District a certain proposal to enter into this contract for the furnishing of certain material and/or services within the State, shall be awarded this Contract, and if said Principal shall well and truly enter into and execute this Contract as may be required by the terms of this Contract and approved by the Capital School District this Contract to be entered into within twenty days after the date of official notice of the award thereof in accordance with the terms of said proposal, then this obligation shall be void or else to be and remain in full force and virtue.

Sealed with _____seal and dated this____day of _____in the year of our Lord two thousand and _____(20__).

SEALED, AND DELIVERED IN THE PRESENCE OF

_____
Name of Bidder (Organization)

Corporate Seal

By:_____
Authorized Signature

Attest _____

_____
Title

_____
Name of Surety

Witness_____

_____

_____
Title

CONSENT OF SURETY

DATE_____

To: Capital School District
945 Forest Street
Dover, Delaware 19904

Gentlemen:

We, the _____

_____
(Surety Company's Address)

_____

a Surety Company authorized to do business in the State of Delaware hereby agrees that if

_____
(Contractor)

_____
(Address)

_____

is awarded the Contract No. _____

We will write the required Performance and/or Labor and Material Bond required by Paragraph 8 of the Instructions to Bidders.

_____
(Surety Company)

By _____
(Attorney-in-Fact)

END OF SECTION

Contract NDHS-35: Turf Field & Track

BID FORM

For Bids Due: _____ To: Capital School District
945 Forest Street
Dover, Delaware 19904

Name of Bidder: _____

Bidder Address: _____

_____

Contact Name: _____ E-Mail Address: _____

Delaware Business License No.: _____ Taxpayer ID No.: _____

(Other License Nos.): _____

Phone No.: ( ) _____ - _____ Fax No.: ( ) _____ - _____

The undersigned, representing that he has read and understands the Bidding Documents and that this bid is made in accordance therewith, that he has visited the site and has familiarized himself with the local conditions under which the Work is to be performed, and that his bid is based upon the materials, systems and equipment described in the Bidding Documents without exception, hereby proposes and agrees to provide all labor, materials, plant, equipment, supplies, transport and other facilities required to execute the work described by the aforesaid documents for the lump sum itemized below:

$_____ ($_____)

ALTERNATES

Alternate BPG-38: Add Synthetic Athletic Turf in "D" Areas of Main Stadium Field.

Add/Deduct _____ ($_____)

UNIT PRICES

N/A

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for one hundred twenty (120) days (Project Manager's Note: Verify and coordinate with Section 00 21 13 Instruction to Bidders.) from the date of opening of bids, and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid (if required).

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

_____
(State of Corporation)

Business Address:_____
_____
_____
_____

Witness: _____ By: _____
(Authorized Signature)

(SEAL)

_____
(Title)

Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement
Bid Bond
Consent of Surety
(Others as Required by Project Manuals)

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor must be listed for each category where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the Owner, it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work.

Subcontractor Category	Subcontractor	Address (City & State)
1. Synthetic Turf		
2. Track Scape		
3.		
4.		
5.		

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date _____.

All the terms and conditions of Contract NDHS-35 Turf Field & Track has been thoroughly examined and are understood.

NAME OF BIDDER: _____

AUTHORIZED REPRESENTATIVE (TYPED): _____

AUTHORIZED REPRESENTATIVE (SIGNATURE): _____

TITLE: _____

ADDRESS OF BIDDER: _____

_____

_____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

BID BOND

TO ACCOMPANY PROPOSAL
(Not necessary if security is used)

KNOW ALL MEN BY THESE PRESENTS That: _____of _____in the County of _____ and State of _____ as Principal, and _____of _____in the County of _____ _____ and State of _____ as Surety, legally authorized to do business in the State of Delaware ('State"), are held and firmly unto the Capital School District in the sum of _____ Dollars (S_____), or percent not to exceed _____ Dollars (S_____) of amount of bid on Contract No. _____ to be paid to the Capital School District for the use and benefit of the Capital School District for which payment well and truly to be made, we do bind ourselves, our and each of our heirs, executors, administrators. and successors, jointly and severally for and in the whole firmly by these presents.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH That if the above bounden Principal who has submitted to the Capital School District a certain proposal to enter into this contract for the furnishing of certain material and/or services within the State, shall be awarded this Contract, and if said Principal shall well and truly enter into and execute this Contract as may be required by the terms of this Contract and approved by the Capital School District this Contract to be entered into within twenty days after the date of official notice of the award thereof in accordance with the terms of said proposal, then this obligation shall be void or else to be and remain in full force and virtue.

Sealed with _____seal and dated this____day of _____in the year of our Lord two thousand and _____(20__).

SEALED, AND DELIVERED IN THE PRESENCE OF

_____
Name of Bidder (Organization)

Corporate Seal

By:_____
Authorized Signature

Attest _____ _____
Title

_____
Name of Surety

Witness_____ _____

_____
Title

CONSENT OF SURETY

DATE_____

To: Capital School District
945 Forest Street
Dover, Delaware 19904

Gentlemen:

We, the _____

_____
(Surety Company's Address)

_____

a Surety Company authorized to do business in the State of Delaware hereby agrees that if

_____
(Contractor)

_____
(Address)

_____

is awarded the Contract No. _____

We will write the required Performance and/or Labor and Material Bond required by Paragraph 8 of the Instructions to Bidders.

_____
(Surety Company)

By _____
(Attorney-in-Fact)

END OF SECTION

Contract NDHS-36: Fencing, Gates & Backstops

BID FORM

For Bids Due: _____ To: Capital School District
945 Forest Street
Dover, Delaware 19904

Name of Bidder: _____

Bidder Address: _____

_____

Contact Name: _____ E-Mail Address: _____

Delaware Business License No.: _____ Taxpayer ID No.: _____

(Other License Nos.): _____

Phone No.: ( ) _____ - _____ Fax No.: ( ) _____ - _____

The undersigned, representing that he has read and understands the Bidding Documents and that this bid is made in accordance therewith, that he has visited the site and has familiarized himself with the local conditions under which the Work is to be performed, and that his bid is based upon the materials, systems and equipment described in the Bidding Documents without exception, hereby proposes and agrees to provide all labor, materials, plant, equipment, supplies, transport and other facilities required to execute the work described by the aforesaid documents for the lump sum itemized below:

$_____ ($_____)

ALTERNATES

Alternate BPG-29: Add (2) Tennis Courts.

Add/Deduct _____ ($_____)

UNIT PRICES

N/A

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for one hundred twenty (120) days (Project Manager's Note: Verify and coordinate with Section 00 21 13 Instruction to Bidders.) from the date of opening of bids, and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid (if required).

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

_____
(State of Corporation)

Business Address:_____
_____
_____
_____

Witness: _____ By: _____
(Authorized Signature)

(SEAL)

_____
(Title)

Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement
Bid Bond
Consent of Surety
(Others as Required by Project Manuals)

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor must be listed for each category where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the Owner, it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work.

Subcontractor Category	Subcontractor	Address (City & State)
1. Fencing		
2.		
3.		
4.		
5.		

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date _____.

All the terms and conditions of Contract NDHS-36 Fencing, Gates & Backstops has been thoroughly examined and are understood.

NAME OF BIDDER: _____

AUTHORIZED REPRESENTATIVE (TYPED): _____

AUTHORIZED REPRESENTATIVE (SIGNATURE): _____

TITLE: _____

ADDRESS OF BIDDER: _____

_____

_____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

BID BOND

TO ACCOMPANY PROPOSAL
(Not necessary if security is used)

KNOW ALL MEN BY THESE PRESENTS That: _____of _____in the County of _____ and State of _____ as Principal, and _____of _____in the County of _____ _____ and State of _____ as Surety, legally authorized to do business in the State of Delaware ('State"), are held and firmly unto the Capital School District in the sum of _____ Dollars (S_____), or percent not to exceed _____ Dollars (S_____) of amount of bid on Contract No. _____ to be paid to the Capital School District for the use and benefit of the Capital School District for which payment well and truly to be made, we do bind ourselves, our and each of our heirs, executors, administrators. and successors, jointly and severally for and in the whole firmly by these presents.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH That if the above bounden Principal who has submitted to the Capital School District a certain proposal to enter into this contract for the furnishing of certain material and/or services within the State, shall be awarded this Contract, and if said Principal shall well and truly enter into and execute this Contract as may be required by the terms of this Contract and approved by the Capital School District this Contract to be entered into within twenty days after the date of official notice of the award thereof in accordance with the terms of said proposal, then this obligation shall be void or else to be and remain in full force and virtue.

Sealed with _____seal and dated this____day of _____in the year of our Lord two thousand and _____(20__).

SEALED, AND DELIVERED IN THE PRESENCE OF

_____
Name of Bidder (Organization)

Corporate Seal

By:_____
Authorized Signature

Attest _____ _____
Title

_____
Name of Surety

Witness_____ _____

_____
Title

CONSENT OF SURETY

DATE_____

To: Capital School District
945 Forest Street
Dover, Delaware 19904

Gentlemen:

We, the _____

_____
(Surety Company's Address)

_____

a Surety Company authorized to do business in the State of Delaware hereby agrees that if

_____
(Contractor)

_____
(Address)

_____

is awarded the Contract No. _____

We will write the required Performance and/or Labor and Material Bond required by Paragraph 8 of the Instructions to Bidders.

_____
(Surety Company)

By _____
(Attorney-in-Fact)

END OF SECTION

Contract NDHS-37: Site Concrete

BID FORM

For Bids Due: _____ To: Capital School District
945 Forest Street
Dover, Delaware 19904

Name of Bidder: _____

Bidder Address: _____

_____

Contact Name: _____ E-Mail Address: _____

Delaware Business License No.: _____ Taxpayer ID No.: _____

(Other License Nos.): _____

Phone No.: ( ) _____ - _____ Fax No.: ( ) _____ - _____

The undersigned, representing that he has read and understands the Bidding Documents and that this bid is made in accordance therewith, that he has visited the site and has familiarized himself with the local conditions under which the Work is to be performed, and that his bid is based upon the materials, systems and equipment described in the Bidding Documents without exception, hereby proposes and agrees to provide all labor, materials, plant, equipment, supplies, transport and other facilities required to execute the work described by the aforesaid documents for the lump sum itemized below:

$_____ ($_____)

ALTERNATES

N/A

UNIT PRICES

N/A

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for one hundred twenty (120) days (Project Manager's Note: Verify and coordinate with Section 00 21 13 Instruction to Bidders.) from the date of opening of bids, and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid (if required).

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

_____
(State of Corporation)

Business Address:_____
_____
_____
_____

Witness: _____ By: _____
(Authorized Signature)

(SEAL)

_____
(Title)

Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement

Bid Bond
Consent of Surety
(Others as Required by Project Manuals)

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor must be listed for each category where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the Owner, it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work.

Subcontractor Category	Subcontractor	Address (City & State)
1. Concrete		
2.		
3.		
4.		
5.		

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date _____.

All the terms and conditions of Contract NDHS-37 Site Concrete has been thoroughly examined and are understood.

NAME OF BIDDER: _____

AUTHORIZED REPRESENTATIVE (TYPED): _____

AUTHORIZED REPRESENTATIVE (SIGNATURE): _____

TITLE: _____

ADDRESS OF BIDDER: _____

_____

_____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

BID BOND

TO ACCOMPANY PROPOSAL
(Not necessary if security is used)

KNOW ALL MEN BY THESE PRESENTS That: _____of _____in the County of _____ and State of _____ as Principal, and _____of _____in the County of _____ _____ and State of _____ as Surety, legally authorized to do business in the State of Delaware ('State"), are held and firmly unto the Capital School District in the sum of _____ Dollars (S_____), or percent not to exceed _____ Dollars (S_____) of amount of bid on Contract No. _____ to be paid to the Capital School District for the use and benefit of the Capital School District for which payment well and truly to be made, we do bind ourselves, our and each of our heirs, executors, administrators. and successors, jointly and severally for and in the whole firmly by these presents.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH That if the above bounden Principal who has submitted to the Capital School District a certain proposal to enter into this contract for the furnishing of certain material and/or services within the State, shall be awarded this Contract, and if said Principal shall well and truly enter into and execute this Contract as may be required by the terms of this Contract and approved by the Capital School District this Contract to be entered into within twenty days after the date of official notice of the award thereof in accordance with the terms of said proposal, then this obligation shall be void or else to be and remain in full force and virtue.

Sealed with _____seal and dated this____day of _____in the year of our Lord two thousand and _____(20__).

SEALED, AND DELIVERED IN THE PRESENCE OF

_____
Name of Bidder (Organization)

Corporate Seal

By:_____
Authorized Signature

Attest _____

_____
Title

_____
Name of Surety

Witness_____

_____

_____
Title

CONSENT OF SURETY

DATE_____

To: Capital School District
945 Forest Street
Dover, Delaware 19904

Gentlemen:

We, the _____

_____
(Surety Company's Address)

_____

a Surety Company authorized to do business in the State of Delaware hereby agrees that if

_____
(Contractor)

_____
(Address)

_____

is awarded the Contract No. _____

We will write the required Performance and/or Labor and Material Bond required by Paragraph 8 of the Instructions to Bidders.

_____
(Surety Company)

By _____
(Attorney-in-Fact)

END OF SECTION

Contract NDHS-38: Bleachers & Grandstands

BID FORM

For Bids Due: _____ To: Capital School District
945 Forest Street
Dover, Delaware 19904

Name of Bidder: _____

Bidder Address: _____

_____

Contact Name: _____ E-Mail Address: _____

Delaware Business License No.: _____ Taxpayer ID No.: _____

(Other License Nos.): _____

Phone No.: ( ) _____ - _____ Fax No.: ( ) _____ - _____

The undersigned, representing that he has read and understands the Bidding Documents and that this bid is made in accordance therewith, that he has visited the site and has familiarized himself with the local conditions under which the Work is to be performed, and that his bid is based upon the materials, systems and equipment described in the Bidding Documents without exception, hereby proposes and agrees to provide all labor, materials, plant, equipment, supplies, transport and other facilities required to execute the work described by the aforesaid documents for the lump sum itemized below:

$_____ ($_____)

ALTERNATES

Alternate BPG-27: Add for Enlarged Grandstand Design – Main Stadium.

Add/Deduct _____ ($_____)

Alternate BPG-28: Add Soccer Grandstand – Auxiliary Stadium.

Add/Deduct _____ ($_____)

UNIT PRICES

N/A

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for one hundred twenty (120) days (Project Manager's Note: Verify and coordinate with Section 00 21 13 Instruction to Bidders.) from the date of opening of bids, and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid (if required).

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

_____
(State of Corporation)

Business Address:_____
_____
_____
_____

Witness: _____ By: _____
(Authorized Signature)

(SEAL)

_____
(Title)

Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement
Bid Bond
Consent of Surety
(Others as Required by Project Manuals)

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor must be listed for each category where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the Owner, it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work.

Subcontractor Category	Subcontractor	Address (City & State)
1. Bleacher/Grandstand Installation		
2.		
3.		
4.		
5.		

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date _____.

All the terms and conditions of Contract NDHS-38 Bleachers & Grandstands has been thoroughly examined and are understood.

NAME OF BIDDER: _____

AUTHORIZED REPRESENTATIVE (TYPED): _____

AUTHORIZED REPRESENTATIVE (SIGNATURE): _____

TITLE: _____

ADDRESS OF BIDDER: _____

_____

_____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

BID BOND

TO ACCOMPANY PROPOSAL
(Not necessary if security is used)

KNOW ALL MEN BY THESE PRESENTS That: _____of _____in the County of _____ and State of _____ as Principal, and _____of _____in the County of _____ _____ and State of _____ as Surety, legally authorized to do business in the State of Delaware ('State"), are held and firmly unto the Capital School District in the sum of _____ Dollars (S_____), or percent not to exceed _____ Dollars (S_____) of amount of bid on Contract No. _____ to be paid to the Capital School District for the use and benefit of the Capital School District for which payment well and truly to be made, we do bind ourselves, our and each of our heirs, executors, administrators. and successors, jointly and severally for and in the whole firmly by these presents.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH That if the above bounden Principal who has submitted to the Capital School District a certain proposal to enter into this contract for the furnishing of certain material and/or services within the State, shall be awarded this Contract, and if said Principal shall well and truly enter into and execute this Contract as may be required by the terms of this Contract and approved by the Capital School District this Contract to be entered into within twenty days after the date of official notice of the award thereof in accordance with the terms of said proposal, then this obligation shall be void or else to be and remain in full force and virtue.

Sealed with _____seal and dated this____day of _____in the year of our Lord two thousand and _____(20__).

SEALED, AND DELIVERED IN THE PRESENCE OF

_____
Name of Bidder (Organization)

Corporate Seal

By:_____
Authorized Signature

Attest _____ _____
Title

_____
Name of Surety

Witness_____ _____

_____
Title

CONSENT OF SURETY

DATE_____

To: Capital School District
945 Forest Street
Dover, Delaware 19904

Gentlemen:

We, the _____

_____
(Surety Company's Address)

_____

a Surety Company authorized to do business in the State of Delaware hereby agrees that if

_____
(Contractor)

_____
(Address)

_____

is awarded the Contract No. _____

We will write the required Performance and/or Labor and Material Bond required by Paragraph 8 of the Instructions to Bidders.

_____
(Surety Company)

By _____
(Attorney-in-Fact)

END OF SECTION

Contract NDHS-39: Site Electrical

BID FORM

For Bids Due: _____ To: Capital School District
945 Forest Street
Dover, Delaware 19904

Name of Bidder: _____

Bidder Address: _____

_____

Contact Name: _____ E-Mail Address: _____

Delaware Business License No.: _____ Taxpayer ID No.: _____

(Other License Nos.): _____

Phone No.: ( ) _____ - _____ Fax No.: ( ) _____ - _____

The undersigned, representing that he has read and understands the Bidding Documents and that this bid is made in accordance therewith, that he has visited the site and has familiarized himself with the local conditions under which the Work is to be performed, and that his bid is based upon the materials, systems and equipment described in the Bidding Documents without exception, hereby proposes and agrees to provide all labor, materials, plant, equipment, supplies, transport and other facilities required to execute the work described by the aforesaid documents for the lump sum itemized below:

$_____ ($_____)

ALTERNATES

Alternate BPG-26: Add Maintenance Building.

Add/Deduct _____ ($_____)

Alternate BPG-31: Scoreboard Upgrade @ Main Stadium.

Add/Deduct _____ ($_____)

Alternate BPG-31A: Scoreboard Upgrade @ Auxiliary Stadium.

Add/Deduct _____ ($_____)

Alternate BPG-32: Add Lighting / Light Bases at Tennis Courts.

Add/Deduct _____ ($_____)

Alternate BPG-33: Add Lighting / Light Bases at Baseball / Softball Stadiums.

Add/Deduct _____ ($_____)

Alternate BPG-37: Site Lighting.

Add/Deduct _____ ($_____)

UNIT PRICES

N/A

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for one hundred twenty (120) days (Project Manager's Note: Verify and coordinate with Section 00 21 13 Instruction to Bidders.) from the date of opening of bids, and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid (if required).

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

_____
(State of Corporation)

Business Address:_____
_____
_____
_____

Witness: _____ By: _____
(Authorized Signature)

(SEAL)

_____
(Title)

Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement
Bid Bond
Consent of Surety
(Others as Required by Project Manuals)

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor must be listed for each category where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the Owner, it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work.

Subcontractor Category	Subcontractor	Address (City & State)
1. Electrical		
2.		
3.		
4.		
5.		

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date _____.

All the terms and conditions of Contract NDHS-39 Site Electrical has been thoroughly examined and are understood.

NAME OF BIDDER: _____

AUTHORIZED REPRESENTATIVE (TYPED): _____

AUTHORIZED REPRESENTATIVE (SIGNATURE): _____

TITLE: _____

ADDRESS OF BIDDER: _____

_____

_____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

BID BOND

TO ACCOMPANY PROPOSAL
(Not necessary if security is used)

KNOW ALL MEN BY THESE PRESENTS That: _____of _____in the County of _____ and State of _____ as Principal, and _____of _____in the County of _____ _____ and State of _____ as Surety, legally authorized to do business in the State of Delaware ('State"), are held and firmly unto the Capital School District in the sum of _____ Dollars (S_____), or percent not to exceed _____ Dollars (S_____) of amount of bid on Contract No. _____ to be paid to the Capital School District for the use and benefit of the Capital School District for which payment well and truly to be made, we do bind ourselves, our and each of our heirs, executors, administrators. and successors, jointly and severally for and in the whole firmly by these presents.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH That if the above bounden Principal who has submitted to the Capital School District a certain proposal to enter into this contract for the furnishing of certain material and/or services within the State, shall be awarded this Contract, and if said Principal shall well and truly enter into and execute this Contract as may be required by the terms of this Contract and approved by the Capital School District this Contract to be entered into within twenty days after the date of official notice of the award thereof in accordance with the terms of said proposal, then this obligation shall be void or else to be and remain in full force and virtue.

Sealed with _____seal and dated this____day of _____in the year of our Lord two thousand and _____(20__).

SEALED, AND DELIVERED IN THE PRESENCE OF

_____
Name of Bidder (Organization)

Corporate Seal

By:_____
Authorized Signature

Attest _____

_____
Title

_____
Name of Surety

Witness_____

_____

_____
Title

CONSENT OF SURETY

DATE_____

To: Capital School District
945 Forest Street
Dover, Delaware 19904

Gentlemen:

We, the _____

_____
(Surety Company's Address)

_____

a Surety Company authorized to do business in the State of Delaware hereby agrees that if

_____
(Contractor)

_____
(Address)

_____

is awarded the Contract No. _____

We will write the required Performance and/or Labor and Material Bond required by Paragraph 8 of the Instructions to Bidders.

_____
(Surety Company)

By _____
(Attorney-in-Fact)

END OF SECTION

Contract NDHS-40: Outdoor Scoreboards

BID FORM

For Bids Due: _____ To: Capital School District
945 Forest Street
Dover, Delaware 19904

Name of Bidder: _____

Bidder Address: _____

_____

Contact Name: _____ E-Mail Address: _____

Delaware Business License No.: _____ Taxpayer ID No.: _____

(Other License Nos.): _____

Phone No.: ( ) _____ - _____ Fax No.: ( ) _____ - _____

The undersigned, representing that he has read and understands the Bidding Documents and that this bid is made in accordance therewith, that he has visited the site and has familiarized himself with the local conditions under which the Work is to be performed, and that his bid is based upon the materials, systems and equipment described in the Bidding Documents without exception, hereby proposes and agrees to provide all labor, materials, plant, equipment, supplies, transport and other facilities required to execute the work described by the aforesaid documents for the lump sum itemized below:

$_____ ($_____)

ALTERNATES

Alternate BPG-31: Scoreboard Upgrade @ Main Stadium.

Add/Deduct _____ ($_____)

Alternate BPG-31A: Scoreboard Upgrade @ Auxiliary Stadium.

Add/Deduct _____ ($_____)

UNIT PRICES

N/A

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for one hundred twenty (120) days (Project Manager's Note: Verify and coordinate with Section 00 21 13 Instruction to Bidders.) from the date of opening of bids, and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid (if required).

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

_____
(State of Corporation)

Business Address:_____
_____
_____
_____

Witness: _____ By: _____
(Authorized Signature)

(SEAL)

_____
(Title)

Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement
Bid Bond
Consent of Surety
(Others as Required by Project Manuals)

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor must be listed for each category where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the Owner, it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work.

Subcontractor Category	Subcontractor	Address (City & State)
1. Scoreboard Installer		
2.		
3.		
4.		
5.		

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date _____.

All the terms and conditions of Contract NDHS-40 Outdoor Scoreboards has been thoroughly examined and are understood.

NAME OF BIDDER: _____

AUTHORIZED REPRESENTATIVE (TYPED): _____

AUTHORIZED REPRESENTATIVE (SIGNATURE): _____

TITLE: _____

ADDRESS OF BIDDER: _____

_____

_____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

BID BOND

TO ACCOMPANY PROPOSAL
(Not necessary if security is used)

KNOW ALL MEN BY THESE PRESENTS That: _____of _____in the County of _____ and State of _____ as Principal, and _____of _____in the County of _____ _____ and State of _____ as Surety, legally authorized to do business in the State of Delaware ('State"), are held and firmly unto the Capital School District in the sum of _____ Dollars (S_____), or percent not to exceed _____ Dollars (S_____) of amount of bid on Contract No. _____ to be paid to the Capital School District for the use and benefit of the Capital School District for which payment well and truly to be made, we do bind ourselves, our and each of our heirs, executors, administrators. and successors, jointly and severally for and in the whole firmly by these presents.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH That if the above bounden Principal who has submitted to the Capital School District a certain proposal to enter into this contract for the furnishing of certain material and/or services within the State, shall be awarded this Contract, and if said Principal shall well and truly enter into and execute this Contract as may be required by the terms of this Contract and approved by the Capital School District this Contract to be entered into within twenty days after the date of official notice of the award thereof in accordance with the terms of said proposal, then this obligation shall be void or else to be and remain in full force and virtue.

Sealed with _____seal and dated this____day of _____in the year of our Lord two thousand and _____(20__).

SEALED, AND DELIVERED IN THE PRESENCE OF

_____
Name of Bidder (Organization)

Corporate Seal

By:_____
Authorized Signature

Attest _____ _____
Title

_____
Name of Surety

Witness_____ _____

_____
Title

CONSENT OF SURETY

DATE_____

To: Capital School District
945 Forest Street
Dover, Delaware 19904

Gentlemen:

We, the _____

_____
(Surety Company's Address)

_____

a Surety Company authorized to do business in the State of Delaware hereby agrees that if

_____
(Contractor)

_____
(Address)

_____

is awarded the Contract No. _____

We will write the required Performance and/or Labor and Material Bond required by Paragraph 8 of the Instructions to Bidders.

_____
(Surety Company)

By _____
(Attorney-in-Fact)

END OF SECTION

SECTION 10 11 00 - SUMMARY OF WORK

1. RELATED DOCUMENTS

1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Sections, apply to work of this Section.

2. CONTRACTS

2.1 The work will be performed under separate prime contracts managed by the Construction Manager.

3. ALTERATIONS & COORDINATION

3.1 Contractor shall be responsible to coordinate their work with the work of others, including, but not limited to, the preparation of general coordination drawings, diagrams and schedules, and control of site utilization, from the beginning of activity, through project close-out and warranty periods.

4. KNOWLEDGE OF CONTRACT REQUIREMENTS

4.1 The Contractor and his Subcontractors, Sub-subcontractors and material men shall consult in detail the Contract Documents for instructions and requirements pertaining to the Work, and at his and their cost, shall provide all labor, materials, equipment and services necessary to furnish, install and complete the work in strict conformance with all provisions thereof.

4.2 The Contractor will be held to have examined the site of the Work prior to submitting his proposal and informed himself, his Subcontractors, Sub-subcontractors and material men of all existing conditions affecting the execution of the Work.

4.3 The Contractor will be held to have examined the Contract Documents and modifications thereto, as they may affect subdivisions of the Work and informed himself, his Subcontractors, Sub-subcontractors and material men of all conditions thereof affecting the execution of the Work.

4.4 The Scope of Work for the Contract is not necessarily limited to the description of each section of the Specifications and the illustrations shown on the Drawings. Include all minor items not expressly indicated in the Contract Documents, or as might be found necessary as a result of field conditions, in order to complete the Work as it is intended, without any gaps between the various subdivisions of work.

4.5 The Contractor will be held to be thoroughly familiar with all conditions affecting labor in the area of the Project including, but not limited to, Unions, incentive pay, procurements, living, parking and commuting conditions and to have informed his Subcontractors and

Sub-subcontractors thereof.

5. CONTRACT DOCUMENTS INFORMATION

5.1 The Contract Documents are prepared in accordance with available information as to existing conditions and locations. If, during construction, conditions are revealed at variance with the Contract Documents, notify the Construction Manager immediately, but no more than three (3) days from the day the variance is first known. Failure to give timely notice shall operate to waive any claim Contractor might otherwise have for an adjustment to Contract Time or Sum as a consequence of such variance.

5.2 The Specifications determine the kinds and methods of installation of the various materials, the Drawings establish the quantities, dimensions and details of materials, the schedules on the Drawings give the location, type and extent of the materials.

5.3 Dimensions given on the Drawings govern scale measurements and large scale drawings govern small scale drawings, except as to anything omitted unless such omission is expressly noted on the large scale drawings.

5.4 The techniques or methods of specifying to record requirements varies throughout text, and may include "prescriptive", "open generic/descriptive", "compliance with standards", "performance", "proprietary", or a combination of these. The methods used for specifying one unit of work has no bearing on requirements for another unit of work.

5.5 Whenever a material, article or piece of equipment is referred to in the singular number in the Contract Documents, it shall be the same as referring to it in the plural. As many such materials, articles or pieces of equipment shall be provided as are required to complete the Work.

5.6 Whenever a material, article or piece of equipment is specified by reference to a governmental, trade association of similar standard, it shall comply with the requirements of the latest publication thereof and amendments thereto in effect on the bid date.

5.7 In addition to the requirements of the Contract Documents, Contractor's work shall also comply with applicable standards of the construction industry and those industry standards are made a part of Contract Documents by reference, as if copied directly into Contract Documents, or as if published copies were bound herein.

5.8 Where compliance with two (2) or more industry standards, contract requirements, or sets of requirements is specified, and overlapping of those different standards or requirements establishes different or conflicting minimums or levels of quality, then the most stringent requirements, which are generally recognized to be also the most costly, is intended and will be enforced, unless specifically detailed language written into the Contract Documents clearly indicates that a less stringent requirement is to be fulfilled. Refer apparently equal but different requirements, and uncertainties as to which level of quality

is more stringent, to Architect for decision before proceeding.

5.9 Reference standards referenced directly in Contract Documents or by governing regulations have precedence over non-reference standards which are recognized in industry for applicability of work.

5.10 Contractor's bid is based on the complete set of Contract Documents including documents not specifically issued as part of the bid pack but referenced in same.

6. SCOPE OF WORK/GENERAL INFORMATION

6.1 A Scope of Work for each contract to be awarded on the project follows in this section. When a Contract has been awarded to a Contractor, the successful Contractor will be listed after the title of the Contract. When no Contract has yet been awarded, no Contractor's name will be listed. Previous Scopes of Work include addendum changes.

6.2 Contractor is responsible for performing the work listed in the Summary of Work for his contract. Contractor is also responsible for knowing the work that has been assigned to preceding contracts. No additional compensation or extension of time will be allowed a Contractor due to his ignorance of the work assigned to his Contract or to other contracts which may affect his work. The Contractor is responsible, however, for all items which are covered in the Specifications and Drawings relating to their Contract if not specifically mentioned in the Summary of Work.

6.3 The Construction Manager will provide on site a source for temporary electric, temporary water and portable sanitation facilities only. It is each Contractor's responsibility to make the necessary connections, including all material for temporary electric and water. Please note that utility charges for office trailers will be the responsibility of the individual Contractors. As well as local permits required for trailers.

6.4 A dumpster will be provided on site for free use by Contractors to dispose of non-hazardous, common, work-related refuse. Clean-up is the responsibility of each Contractor. Clean up shall be performed on a daily basis. Contractors not complying will be advised in writing and back charged for all costs associated with the clean up of their work.

6.5 Contractors are reminded that there are limited storage areas available on site. Off site storage will be the responsibility of each individual Contractor.

6.6 Office trailer permits off site will be the responsibility of each individual Contractor. On site Contractor's field offices, one (1) per Contractor, if required, will be located as directed by the Construction Manager.

6.7 Contractor will be prepared to discuss and submit a detailed project schedule seven (7) days after receipt of Notice to Proceed and to begin its submittal process. The Project

Schedule is an integral part of this contract. Certain construction sequences and priorities must take place in order to meet the target dates. Concentrated work periods will occur and each Contractor is responsible to staff the project as required by the current Construction Schedule or as directed by the Construction Manager. Contractor will cooperate with the Construction Manager in planning and meeting the required sequences of work and Project Schedule as periodically updated by the Construction Manager.

6.8 All bids must include insurance limits in accordance with Article 11 of the Section 00 73 00 SUPPLEMENTARY CONDITIONS.

6.9 Hoisting, scaffolding and material handling is the responsibility of each Contractor, unless otherwise noted.

6.10 Contractor will be responsible for layout of its own work. The Construction Manager will provide benchmark and layout of the building line.

6.11 Contractor will be responsible to keep clean public roadways soiled by construction traffic on a daily basis. If cleaning is not done, the Construction Manager may perform the cleaning on an overtime basis and backcharge the Contractor responsible.

6.12 Contractor Scopes of Work and Schedule are interrelated. Familiarity with each is required.

6.13 The Construction Manager will provide testing services for soil, concrete and steel. Other testing as required by the Contract Documents will be in accordance with the technical specifications and/or the individual scope of work. Refer to Specification Section 01 45 00 - QUALITY CONTROL.

6.14 Safety is the responsibility of each individual Contractor. The project will be governed under the guidelines of OSHA.

6.15 Inter-Contractor shop drawing distribution will be performed by the Construction Manager. Contractor is individually responsible for either coordinating his work with these distributed drawings or notifying the Construction Manager, in writing, of any discrepancies.

6.16 Coordination with other trades will be required. The Contractor will be required to attend periodic coordination meetings with other trades where requirements, conflicts and coordination issues will be discussed and resolved. Attendance when requested will be mandatory. If inter-Contractor coordination is not satisfactorily performed, the conflicting Contractors shall mutually share the cost to relocate and/or reinstall their work.

6.17 Contractor shall submit a schedule of values to the Construction Manager through the

Building Blok Management Program prior to the submission of their first invoice for approval on AIA G702/CMa, Application for Payment and G703, Continuation Sheet.

6.18 Contractor is expected to review and coordinate its Work with the complete set of Contract Documents, including all items noted as by his trade whether or not shown on that particular set of drawings. Documents are available at the site for review.

6.19 Contractor is responsible for obtaining all necessary permits required for his work, including street permits. Unless otherwise noted, building permit shall be secured by the Construction Manager. Any subcontractor who will be restricting access to street, right of way or adjacent property must notify the Construction Manager 48 hours in advance.

The documents require the Subcontractor to secure their own permits. In some jurisdictions (Middletown, Newark, etc.) the permit (Mechanical, HVAC, etc.) is included in the Building Permit and you must specifically advise Subcontractor of the assessment and amount in order to avoid having them not be responsible.

6.20 Contractor's License: Submit a copy of all business licenses required by local and state agencies.

6.21 Contractor shall absorb, without additional compensation, any and all costs of working beyond normal hours to maintain job progress in accordance with the current construction schedule.

6.22 No asbestos or PCB's in or on any material or equipment will be accepted or allowed on this project. All hazardous materials will be treated in accordance with all State and Federal regulations.

6.23 Daily clean up of the work is the responsibility of each individual Contractor which includes broom cleaning of their debris as required. Contractor will be individually back charged by the Construction Manager for clean up not satisfactorily performed by the Contractor.

6.24 In the event asbestos is uncovered, the Contractor shall notify the Construction Manager of the areas requiring removal of asbestos. The Construction Manager shall then coordinate the removal with the Owner.

6.25 This project is to be constructed adjacent to and in existing buildings. Contractor shall exercise all due precautions to minimize noise, air pollution and any other construction hazards which in any way would cause discomfort or danger to the occupants of the existing building in the area.

6.26 Existing mechanical, electrical, plumbing, sprinkler, medical gas, fire alarm, etc. systems will be shut off and locked out by the Owner as required by the Work. Tie-in's and modifications to those systems will be performed by the specific Contractor associated

with the work as indicated in the Contract Documents. Re-energizing and re-start up of all systems should be performed by the Owner.

6.27 The Safety Cable System shall not be altered or removed without a written request submitted to the Project Manager with a copy to the Field Manager. It shall be the responsibility of each and every Contractor that is removing or altering the Safety Cable System to maintain the fall protection safety provided by the safety cable and not leave the area unprotected. Each and every Contractor shall be responsible to re-install the Safety Cable System immediately after work is completed. Each and every Contractor shall be responsible to re-install the Safety Cable System in accordance to OSHA standards.

6.28 Normal work hours for this project are from 7:00 a.m. to 3:30 p.m. Any work to be performed outside of these hours must receive prior approval from the Construction Manager. Requests to work beyond normal work hours shall be submitted at least 48 hours prior.

6.29 Contractor is responsible for having a competent project superintendent/foreman on-site during all work performed under its contract.

6.30 In the event the Contractor has non-English speaking employees or subcontractors on the project, they shall have a superintendent or foreman on site, at all times, who speaks English and can communicate with Contractor's employees. Should the Contractor fail to meet this requirement, at any time, Construction Manager may direct all Work to stop until the proper supervision is on site. The Contractor will be responsible for maintaining the project work schedule and make up at its own expense, any delay to the Schedule resulting from the work stoppage.

6.31 Punch List Procedures: Contractor shall be given a copy of the punch list with his appropriate work identified. Contractor shall have nine (9) calendar work days to complete its punch list work. On the 10th day or as determined by the Construction Manager, the Construction Manager shall employ other contractors, as required, to complete any incomplete punch list work and retain from the appropriate Contractors retainage all costs incurred.

6.32 Contractor shall provide the necessary safety barricades and railings required to complete their work and comply with all OSHA, local code and contract specifications.

CONTRACT NO. NDHS-33: SITE, FIELD STADIUMS AND ACCESSORIES

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 31	Earthwork
Division 32	Exterior Improvements
Section 01 74 19	Construction Waste Management and Disposal
Section 01 81 13	Sustainable Design Requirements LEED for Schools
Section 03 30 00	Cast-In-Place Concrete
Section 11 66 23	Track and Field Equipment
Section 11 68 20	Outdoor Athletic Equipment
Section 11 68 20	Stadium Padding
Section 12 93 00	Site Furnishings
Section 22 08 00	Common Work Results for Plumbing
Section 32 12 16	Asphalt Paving
Section 32 18 18	Tennis Court Pavement System
Section 32 84 00	Irrigation
Section 32 92 00	Meadow Planting
Section 32 92 23	Lawns
Section 32 93 00	Planting

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

- Provide sitework, utilities for work assigned with the contract.
- Furnish, install, maintain and remove sediment control system including sediment control plan. Maintain sediment control until substantial completion established by DNREC.
- Clearing and grubbing as necessary to accomplish work indicated on plans and specifications.
- Topsoil shall be stripped and stockpiled as necessary to accomplish your work.
- Rough grading for area defined on site drawings for buildings, lawn areas, bituminous pathways. Preparation of subgrade for building slabs.
- This Contractor is responsible for all excavation and backfill for work associated with this contract scope.
- Provide a certified construction reviewer (CCR) to perform inspections and provided written

reports; signed and sealed by professional engineer. Coordinate with DNREC.

- Provide all permits related to work for this project outside of building permit.
- Install complete all practice fields per base bid and alternates.
- Contractor to provide all permits; including City plumbing permit.
- Furnish, install and remove temporary orange construction fencing as required. To protect your work areas during construction.
- Proof rolling of limit of excavation.
- This contractor to provide all utility work as detailed on plans and specifications for Bid Package G, see documentation or plans.
- Backfilling as detailed below is the responsibility of this Contractor. Soil types shall be in accordance with DelDot standard specifications.
- It is the intent to use on site material and not imported fill. The use of this onsite material shall conform to the compaction requirements as specified on the civil drawings. If the on site material does not meet those requirements or if there is insufficient on site material available, this contractor shall import at no additional expense to the project sufficient material to complete the work.
- Provide perimeter protection of all excavated areas until suitably backfilled.
- Install synthetic turf auxillary stadium complete.
- Provide all track and field equipment.
- Provide street cleaning of mud, etc. on daily basis.
- Provide all site furnishings.
- Include all costs for temporary barricades, arrows, pedestrian protection, flagmen, etc. required to complete the work.
- Base bid shall include all standard dewatering measures; utilizing trenches, crocks, stone and portable pumping measures. This contractor to provide these measures as required to perform their work.
- The Contractor shall provide and maintain all temporary access road to and from the work areas.
- Temporary water will be the responsibility of the individual Contractors. The Construction

Manager will not provide this service.

- Install all grading for berms and filled areas.
- Install topsoil on entire site areas per plans/ material from on site stockpile.
- Provide all lawn areas as indicated on drawings.
- Provide alternates to supply meadow planting in lieu of standard turf.
- Provide all planting and mulching as indicated.
- Provide all utility connections as indicated including all taps and distribution in all areas documented for Bid Package G.
- Contractor to provide a $40,000 allowance for work to be determined by the Construction Manager.
- Provide irrigation trunk lines as indicated on plans.
- Provide and install perimeter berm around designated are of project site. (Material to be used from on site stockpile.)
- This Contractor to provide all underfield drainage, curbs, and stone base layer graded to tolerance within final grade to be turned over to the turf contractor for final installation.
- This Contractor to provide grading, drainage, curbs, stone and paving in preparation fo the track contractor to perform their work.
- Include CCR reporting for duration of construction.

CONTRACT NO. NDHS-34: GENERAL CONSTRUCTION

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 017419	Construction Waste Management and Disposal
Section 018113	Sustainable Design Requirements LEED for Schools
Section 033000	Cast-In-Place Concrete
Section 042000	Unit Masonry
Section 04 72 00	Cast Stone
Section 05 12 00	Structural Steel Framing
Section 05 21 00	Steel Joist Framing
Section 05 31 00	Steel Decking
Section 05 40 00	Cold-Formed Metal Framing
Section 05 50 00	Metal Fabrications
Section 06 10 00	Rough Carpentry
Section 06 20 00	Finish Carpentry
Section 07 21 00	Thermal Insulation
Section 07 26 16	Under-Slab Vapor Barrier/Retarder
Section 07 42 13	Metal Wall Panels
Section 07 53 00	Elastomeric Membrane Roofing
Section 07 62 00	Sheet Metal Flashing and Trim
Section 07 71 00	Roof Specialties
Section 07 72 00	Roof Accessories
Section 07 90 05	Joint Sealers
Section 08 11 13	Hollow Metal Doors and Frames
Section 08 33 23	Overhead Coiling Doors
Section 08 33 33	Coiling Counter Doors
Section 08 43 13	Aluminum-Framed Storefronts
Section 08 06 71	Door Hardware Schedule
Section 08 71 00	Door Hardware
Section 08 80 00	Glazing
Section 08 91 00	Louvers
Section 09 05 61	Common Work Results for Flooring Preparation
Section 09 21 16	Gypsum Board Assemblies
Section 09 51 00	Acoustical Ceilings
Section 09 65 66	Resilient Athletic Flooring
Section 09 67 00	Fluid-Applied Flooring
Section 09 68 13	Tile Carpeting
Section 09 90 00	Painting and Coating
Section 10 11 01	Visual Display Boards

Section 10 21 13.19	Solid Composite Toilet Compartments
Section 10 28 00	Toilet, Bath, and Laundry Accessories
Section 10 44 00	Fire Protection Specialties
Section 10 51 00	Lockers
Section 11 40 00	Foodservice Equipment
Section 12 21 13	Horizontal Louver Blinds
Section 12 34 00	Laminate Clad Casework
Section 12 36 00	Countertops, Backsplashes and Window Stools

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

This contract will be for the General Building package associated with the ancillary buildings located throughout the site of Dover High School. They include the following:

- North Building Fieldhouse
- East Building Fieldhouse
- West Building Fieldhouse
- Maintenance Building (Alternate)
- Ticket Booths (Alternate)
- Dugouts

It will be the responsibility of NDHS- Contract 34 to provide these building in their entirety from subgrade to final acceptance. This includes all building construction as well as the MEP work required. The Owner will provide the building permit. The Contractor will be responsible for all other permits required by the City of Dover, Kent County or any other governing agency having jurisdiction over this work site.

- This Contractor to provide secure dry storage for all doors, frames and hardware until work has been installed.

- All field trimming required to adjust to existing conditions.

- This Contractor shall include in the base an allowance of $30,000 for work to be determined by the Construction Manager.

- This Contractor shall at a minimum provide a fire extinguisher rated not less than 2A for each structure while construction is underway.

CONTRACT NO. NDHS-35: TURF FIELD & TRACK

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 2	Sitework
Section 32 18 16.16	Artificial Turf
Section 37 18 17	Synthetic Track Surfacing System

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

- This Contractors work to start at the top of the vertical drawing gravel blanket. Provide complete turf field system.
- Provide warranty as specified.
- Provide an IAAF approved synthetic track system.
- Coordinate with work of site contractor to ensure a timely installation of work under your scope.
- Contractor to include an allowance of $20,000 for work to be determined by Construction Manager.

CONTRACT NO. NDHS-36: FENCING, GATES & BACKSTOPS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 32	Exterior Improvements
Section 323113	Chain Link Fences and Gates
Section 313115	Ornamental Steel Fencing

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

- All chain link fencing, gates, backstops, dugouts and ornamental fencing as indicated in contract documents.
- Supply and install all concrete foundations and setting pads for the scope of your work.
- Provide and install "grounding connections" as required.
- Warranty period five (5) years from date of substantial completion to be included in your proposal.
- All work areas to be cleaned up daily. Removal of debris, trash and excess materials to be the responsibility of this contractor.
- Include an allowance of $20,000 for work to be determined by Construction Manager.

CONTRACT NO. NDHS-37: SITE CONCRETE

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 3	Concrete
Division 31	Earthwork
Section 0330000	Concrete

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

- Provide all concrete, sidewalks, aprons, pads seats and concrete paving.
- Provide curbs associated with sidewalks and paved areas.
- This Contractor will be responsible for laying out all concrete work as shown on the contract documents.
- This Contractor to furnish and install reinforcing steel, admixtures, curing compound, sealers as required in the Contract Documents.
- Provide and install insulation as related to your work.
- Underslab vapor barrier, insulation, reglets, waterstops, control and construction joints (including required caulking at control and construction joints).
- Placement of related items furnished under other specification sections.
- All blockouts and embedments required by plans and specifications.
- This contractor to perform all scoring, coloring and cutting of concrete as detailed.
- ADA truncated domes and markings to be supplied and installed by this contractor.
- Provide and install all joint sealants associated with your work.
- Daily clean up of your work area is required by this contractor. You will be responsible for removal of all debris and trash you accumulate.
- Include all excavation, backfill, stone base, vapor barriers, etc. as required to perform your

work.

- This Contractor shall include an allowance of $25,000 for work to be determined by Construction Manager.

CONTRACT NO. NDHS-38 BLEACHER & GRANDSTANDS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 3	Concrete
Division 13	Special Construction
Section 033000	Cast-in-place Concrete

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

- Bleachers as designed and indicated on plans and specifications.
- Provide all engineering, materials, freight, concrete, reinforcing bar, installation, related sitework and supervision to provide grandstand seating systems.
- This contractor shall be responsible for any local permitting and code compliance.
- Shop drawings, submittal product data shall be submitted per contract documents.
- Warranty period to be no less than two (2) years.
- Clean up of all debris from work of this contractor to be included daily.
- Include an allowance of $15,000 for work to be determined by Construction Manager.

CONTRACT NO. NDHS-39 SITE ELECTRICAL

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Division 23	Mechanical
Division 26	Electrical
Division 31	Earthwork
Section 03 30 00	Concrete

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

- Provide a complete site lighting package including all bases, conduit and wire.
- Excavation and backfill for underground electrical work as required below is the responsibility of this Contractor. Soil types shall be in accordance with Del DOT standard specifications.
- Backfilling is the responsibility of this Contractor. Soil types shall be in accordance with project documents.
- Concrete for duct banks, light standards, above ground conduit encasement, equipment bases and any other concrete work specifically related to the electrical work. Include requirements of Kent County, State and local codes for concrete encasement.
- Rough in and final connection and related work for site lighting, stadium lighting and scoreboards.
- Permits and inspections.
- Penetrations through walls, floors, etc. including cutting, patching and fire safing.
- Testing.
- Clean up.
- All guarantees and warranties to begin at the substantial completion of the entire project. Maintain equipment prior to substantial completion.
- Hoisting, rigging and scaffolding.

- Provide all primary service work, including all utility company related costs/fees for this work.
- Grounding of all work related to your scope.
- Complete stadium sound system.
- As-built drawings.
- All light poles and wiring.
- Furnish and install complete gear package.
- Furnish and install complete sound system.
- Furnish and install complete conduit and wiring system per drawings.
- Contractor to include $35,000 allowance for work to be designated by Construction Manager.

CONTRACT NO. NDHS-40: OUTDOOR SCOREBOARDS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section	Outdoor Scoreboards

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

- Furnish and install all outdoor scoreboards as detailed in the Contract Documents.
- Include all necessary excavation, concrete, rebar, conduits, wiring and accessories.

END OF SECTION

SECTION 01 23 00 - ALTERNATES

1. GENERAL PROVISIONS

1.1 The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the Work specified in this Section.

1.2 Refer to provisions in AIA Document A201/CMa - 1992 Edition, GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION WHERE THE CONSTRUCTION MANAGER IS NOT A CONSTRUCTOR for requirements in addition to those specified in Division 1.

1.3 For work being constructed under separate prime contracts, provisions of this Section apply to each contract being bid.

2. BASE BID

2.1 The Base Bid shall consist of all work shown or specified in the Contract Documents, exclusive of any Additive Alternates specified herein.

2.2 The Base Bid shall include all work in any Subtractive Alternates specified herein.

3. ALTERNATES

3.1 State in the Bid Form the amount to be added to the Base Bid for each Alternate specified.

3.2 See Section 002113 - INSTRUCTIONS TO BIDDERS for related information.

3.3 The description of Alternates contained herein is in summary form. Detailed requirements for materials and execution shall be as specified in other sections and as shown on drawings.

Alternate BPG-25: Bermuda Grass at Practice Field (unit pricing per field).
Provide unit pricing for executing practice fields (excluding softball/baseball) in Bermuda grass.

Add $_____

Alternate BPG-26: Add Maintenance Building.
Provide pre-engineered metal building (complete) as indicated on drawings and specifications.

Add $_____

Alternate BPG-27: Add for Enlarged Football Grandstand Design – Main Stadium.
Provide increased seating capacity grandstands at main stadium per drawings and specifications.

Add $_____

Alternate BPG-28: Add Soccer Grandstand – Auxiliary Stadium.
Provide grandstand (complete) at west side of Auxiliary Stadium per drawings and specifications.

Add $_____

Alternate BPG-29: Add (2) Tennis Courts.
Provide two additional tennis courts (complete) adjacent to six indicated in base bid.

Add $_____

Alternate BPG-30: Add Ticket Booths @ Main & Auxiliary Stadium.
Provide four, two at Main/two at Auxiliary Stadia entrances, ticket booths (complete) per drawings.

Add $_____

Alternate BPG-31: Scoreboard Upgrade @ Main Stadium.
Provide upgraded scoreboard (complete) at Main Stadium per drawings and specifications.

Add $_____

Alternate BPG-31A: Scoreboard Upgrade @ Auxiliary Stadium.
Provide upgraded scoreboard (complete) at Auxiliary Stadium per drawings and specifications.

Add $ _____

Alternate BPG-32: Add Lighting / Light Bases at Tennis Courts.
Provide lighting (base and poles, complete) for tennis area. Typical of 6 poles at locations shown.

Add $_____

Alternate BPG-33: Add Lighting / Light Bases at Baseball / Softball Stadiums.
Provide lighting (base and poles, complete) for competition baseball and softball fields.

Add $_____

Alternate BPG-34: Add Grass (Bermuda) at Auxiliary Stadium Field
Provide Bermuda grass athletic field (complete, including drainage, striping) per drawings.

Add $_____

Alternate BPG-37: Site Lighting.
Fixture Types L1, L2 & L2H
Provide price to use 315W Master Color Elite electronic ballast/lamp system in specified fixture in lieu of 400WPSMH lamps. Provide site lighting calculations as part of the shop drawing review.

Fixture Type L3
Provide price to use 90W Cosmopolis electronic ballast/lamp system in specified fixture in lieu of 100WPSMH lamps. Provide site lighting calculations as part of the shop drawing review.

Add $_____

Alternate BPG-38: Add Synthetic Turf in "D" Areas of Main Stadium Field.
Execute areas bounded by football endzones and arc of athletic track in Synthetic Athletic Turf. Turf (complete) is to match type and colors utilized as base-bid for Main Stadium playing field.

Add $_____

END OF SECTION

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GENERAL COMMISSIONING REQUIREMENTS
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GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

A. This Section includes general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned.

B. Related Sections include the following:

1. Division 01 Section *"HVAC Commissioning Requirements"* for specific requirements for commissioning HVAC systems.

2. Division 01 Section *"Electrical Commissioning Requirements"* for specific requirements for commissioning electrical systems.

3. Division 01 Section *"Plumbing System Commissioning Requirements"* for specific requirements for commissioning Plumbing systems.

4. Division 01 Section *"Contract Closeout"* for specific requirements for closeout at substantial and final completion.

5. Division 01 Section *"Contract Closeout"* for Specific Requirements for training and demonstration of systems to Owner.

6. Division 01 Section *"Contract Closeout"* for Specific Requirements related to the Preparation of systems operation and maintenance manuals.

1.03 DEFINITIONS

A. CxA: Commissioning Authority.

B. OPR: Owner's Project Requirements.

C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

D. TAB: Testing, Adjusting, and Balancing.

1.04 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract. The CxA for this project shall be performed by EMO Energy Solution, 3141 Fairview Park Drive, Suite 450, Falls Church, Virginia 22042, (703) 205-0445-telephone, (703) 205-0449-fax.
2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

1.05 OWNER'S RESPONSIBILITIES

A. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:

1. Coordination meetings.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Testing meetings.
4. Demonstration of operation of systems, subsystems, and equipment.

1.06 CONTRACTOR'S RESPONSIBILITIES

A. Provide utility services required for the commissioning process.

B. Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:

1. Participate in commissioning and construction-phase coordination meetings.
2. Participate in maintenance orientation and inspection.
3. Participate in operation and maintenance training sessions.
4. Participate in final review at acceptance meeting.
5. Certify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
6. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
7. Review and approve final commissioning documentation.
8. Certify that all pre-test work is complete and operational prior to scheduling performed testing by CxA.

C. Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:

1. Participate in commissioning and construction-phase coordination meetings.
2. Participate in maintenance orientation and inspection.
3. Participate in procedures meeting for testing.
4. Participate in final review at acceptance meeting.
5. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to CxA for incorporation into the commissioning plan. Update schedule on a weekly basis throughout the construction period.
6. Provide information to the CxA for developing construction-phase commissioning plan.
7. Participate in training sessions for Owner's operation and maintenance personnel.
8. Provide updated Project Record Documents to the CxA on a daily basis.
9. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA, as specified in Division 01 Section "Operation and Maintenance Data."
10. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures and participate in testing of installed systems, subsystems, and equipment.

1.07 CxA'S RESPONSIBILITIES

A. Organize and lead the commissioning team.

B. Prepare a construction-phase commissioning plan. Collaborate with Contractor and with subcontractors to develop test and inspection procedures. Include design changes and scheduled commissioning activities coordinated with overall Project schedule. Identify commissioning team member responsibilities, by name, firm, and trade specialty, for performance of each commissioning task.

C. Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss progress of the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The CxA shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.

D. At a mutually agreed upon time, conduct an initial construction-phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; and Project completion.

E. Observe and inspect construction and report progress and deficiencies. In addition to compliance with the Contract Documents, inspect systems and equipment installation for adequate accessibility for maintenance and component replacement or repair.

F. Prepare Project-specific test and inspection procedures and checklists.

G. Schedule, direct, witness, and document tests, inspections, and systems startup.

H. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.

I. Certify date of acceptance and startup for each item of equipment for start of warranty periods.

J. Review Project Record Documents for accuracy. Request revisions from Contractor to achieve accuracy. Project Record Documents requirements are specified in Division 01 Section "Project Record Documents."

K. Review and comment on operation and maintenance documentation and systems manual outline for compliance with the Contract Documents. Operation and maintenance documentation requirements are specified in Division 01 Section "Operation and Maintenance Data."

L. Assemble the final commissioning documentation, including the commissioning report and Project Record Documents.

1.08 COMMISSIONING DOCUMENTATION

A. Commissioning Plan: A document, prepared by CxA, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited to the following:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.
2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
3. Identification of systems and equipment to be commissioned.
4. Description of schedules for testing procedures along with identification of parties involved in performing and verifying tests.
5. Identification of items that must be completed before the next operation can proceed.
6. Description of responsibilities of commissioning team members.
7. Description of observations to be made.
8. Description of requirements for operation and maintenance training, including required training materials.
9. Description of expected performance for systems, subsystems, equipment, and controls.
10. Schedule for commissioning activities with specific dates coordinated with overall construction schedule.
11. Identification of installed systems, subsystems, and equipment, including design changes that occurred during the construction phase.
12. Process and schedule for documenting changes on a continuous basis to appear in Project Record Documents.
13. Process and schedule for completing prestart and startup checklists for systems, subsystems, and equipment to be verified and tested.
14. Step-by-step procedures for testing systems, subsystems, and equipment with descriptions for methods of verifying relevant data, recording the results obtained, and listing parties involved in performing and verifying tests.

B. Test Checklists: CxA, with assistance of Contractor and Subcontractors, shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist. Specific checklist content requirements are specified in Division 01 Section *"HVAC Commissioning Requirements"*, *"Electrical Commissioning Requirements"* and *"Plumbing System Commissioning Requirements."* Test checklists will be jointly developed as the project progresses. Each checklist, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:

1. Name and identification code of tested item.
2. Test number.
3. Time and date of test.
4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
5. Dated signatures of the person performing test and of the witness, if applicable.
6. Individuals present for test.
7. Deficiencies.
8. Issue number, if any, generated as the result of test.

C. Certificate of Readiness: Certificate of Readiness shall be signed by Contractor, Subcontractor(s), Installer(s), and CxA certifying that systems, subsystems, equipment, and associated controls are ready for testing. Completed test checklists signed by the responsible parties shall accompany this certificate.

D. Test and Inspection Reports: CxA shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. CxA shall compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.

E. Corrective Action Documents: CxA shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.

F. Issues Log: CxA shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.

1. Creating an Issues Log Entry:

   a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
   b. Assign a descriptive title of the issue.
   c. Identify date and time of the issue.
   d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
   e. Identify system, subsystem, and equipment to which the issue applies.
   f. Identify location of system, subsystem, and equipment.
   g. Include information that may be helpful in diagnosing or evaluating the issue.

h. Note recommended corrective action.
i. Identify commissioning team member responsible for corrective action.
j. Identify expected date of correction.
k. Identify person documenting the issue.

2. Documenting Issue Resolution:

a. Log date correction is completed or the issue is resolved.
b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
c. Identify changes to the Contract Documents that may require action.
d. State that correction was completed and system, subsystem, and equipment is ready for retest, if applicable.
e. Identify person(s) who corrected or resolved the issue.
f. Identify person(s) documenting the issue resolution.

3. Issues Log Report: On a periodic basis, but not less than for each commissioning team meeting, CxA shall prepare a written narrative for review of outstanding issues and a status update of the issues log. As a minimum, CxA shall include the following information in the issues log and expand it in the narrative:

a. Issue number and title.
b. Date of the identification of the issue.
c. Name of the commissioning team member assigned responsibility for resolution.
d. Expected date of correction.

G. Commissioning Report: CxA shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the Contract Documents. The commissioning report shall include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances in the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents and those that do not meet requirements of the Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.
2. Commissioning plan.
3. Testing plans and reports.
4. Corrective modification documentation.
5. Issues log.
6. Completed test checklists.
7. Listing of off-season test(s) not performed and a schedule for their completion.

H. Systems Manual: CxA shall gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:
1. Project Record Documents as specified in Division 01 Section "Project Record Documents."
2. Final commissioning plan.

3. Commissioning report.
4. Operation and maintenance data as specified in Division 01 Section "Operation and Maintenance Data."

1.09 SUBMITTALS

A. Test Checklists and Report Forms: CxA shall submit sample checklists and forms to Contractor quality-control manager and subcontractors for review and comment. Submit two copies of each checklist and report form.

B. Test and Inspection Reports: CxA shall submit test and inspection reports.

C. Corrective Action Documents: CxA shall submit corrective action documents.

1.10 QUALITY ASSURANCE

A. Instructor Qualifications: Factory-authorized service representatives, experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.

B. Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

1.11 COORDINATION

A. Coordinating Meetings: CxA shall conduct coordination meetings of the commissioning team to review progress on the commissioning plan, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.

B. Pretesting Meetings: CxA shall conduct pretest meetings of the commissioning team to review startup reports, pretest inspection results, testing procedures, testing personnel and instrumentation requirements, and manufacturers' authorized service representative services for each system, subsystem, equipment, and component to be tested.

C. Testing Coordination: CxA shall coordinate sequence of testing activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

D. Manufacturers' Field Services: CxA and Contractor shall coordinate services of manufacturers' field services.

1.12 ALTERNATES

A. Refer to Division 01, -*Alternates* for description of work under this section affected by alternates.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

A. Training Preparation Conference: Before operation and maintenance training, CxA shall convene a training preparation conference to include Owner's operation and maintenance personnel, Contractor, and subcontractors. In addition to requirements specified in Division 01 Section "Demonstration and Training," perform the following:

1. Review installed systems, subsystems, and equipment.
2. Review instructor qualifications.
3. Review instructional methods and procedures.
4. Review training module outlines and contents.
5. Review course materials (including operation and maintenance manuals).
6. Inspect and discuss locations and other facilities required for instruction.
7. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
8. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

B. Training Modules: Develop an instruction program that includes individual training modules for each system, subsystem, and equipment as specified in Division 01 Section "Demonstration and Training."

END OF SECTION

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SECTION 019114

PLUMBING COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

A. This Section includes requirements for commissioning the plumbing system and its subsystems and equipment. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."

B. Related Sections include the following:

1. Division 01 Section "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section.

C. The following systems and/or equipment shall be commissioned:

1. Domestic hot water re-circulating system.
2. Domestic hot water heaters.
3. Backflow preventers.
4. Plumbing Fixtures.
5. Domestic water meter (including interlock to ATC system).
6. Thermostatic mixing valves below hand sinks/lavs.
7. Trap priming stations.
8. Shower head flow rates.

1.03 DEFINITIONS

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of plumbing systems, electrical, communications, controls for plumbing systems, and other related systems.

B. CxA: Commissioning Authority.

C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

D. TAB: Testing, Adjusting, and Balancing.

1.04 CONTRACTOR'S RESPONSIBILITIES

A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Contractor:

1. Attend procedures meeting for TAB Work.
2. Certify that TAB Work is complete.

C. Mechanical Contractor:

1. Attend TAB verification testing.
2. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.

D. HVAC Instrumentation and Control Contractor: With the CxA, review control designs for compliance with the Contract Documents, controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions.

E. TAB Subcontractor:

1. Contract Documents Review: With the CxA, review the Contract Documents before developing TAB procedures.

    a. Verify the following:

        1) Accessibility of equipment and components required for TAB Work.
        2) Adequate number and placement of duct balancing dampers to allow proper balancing while minimizing sound levels in occupied spaces.
        3) Adequate number and placement of balancing valves to allow proper balancing and recording of water flow.
        4) Adequate number and placement of test ports and test instrumentation to allow reading and compilation of system and equipment performance data needed to conduct both TAB and commissioning testing.
        5) Air and water flow rates have been specified and compared to central equipment output capacities.

    b. Identify discontinuities and omissions in the Contract Documents.
    c. This review of the Contract Documents by the TAB Subcontractor satisfies requirements for a design review report as specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."

2. Additional Responsibilities: Participate in tests specified in Division 23 Sections "Instrumentation & Controls of HVAC & Plumbing Systems."

F. Electrical Contractor:

1. With the Mechanical Contractor, coordinate installations and connections between and among electrical and plumbing systems, subsystems, and equipment.
2. Attend TAB verification testing.

1.05 COMMISSIONING DOCUMENTATION

A. The following are in addition to documentation specified in Division 01 Section "General Commissioning Requirements."

B. Test Checklists: CxA with assistance of Contractor shall develop test checklists for plumbing systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. In addition to the requirements specified in Division 01 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:

1. Calibration of sensors and sensor function.
2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.
3. Control sequences for plumbing systems.
4. Strength of control signal for each set point at specified conditions.
5. Responses to control signals at specified conditions.
6. Sequence of response(s) to control signals at specified conditions.
7. Electrical demand or power input at specified conditions.
8. Power quality and related measurements.
9. Expected performance of systems, subsystems, and equipment at each step of test.
10. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.
11. Interaction of auxiliary equipment.
12. Issues log.

1.06 SUBMITTALS

A. The following submittals are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.

C. Certificate of Readiness: CxA shall compile certificates of readiness from Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

D. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed. Certification shall include completed checklists provided by TAB Subcontractor as specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."

E. Certified Pipe Cleaning and Flushing Report: CxA shall certify that pipe cleaning, flushing, hydrostatic testing, and chemical treating have been completed.

F. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them in systems manual and commissioning report.

G. Corrective Action Documents: CxA shall submit corrective action documents.

H. Certified TAB Reports: CxA shall submit verified, certified TAB reports.

I. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

1.07 ALTERNATES

A. Refer to Division 01 Section, “Alternates” for description of work under this section affected by alternates.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 TESTING PREPARATION

A. Prerequisites for Testing:

1. Certify that plumbing systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the Contract Documents; and that Certificates of Readiness are signed and submitted.
2. Certify that plumbing instrumentation and control systems have been completed and calibrated; are operating according to the Contract Documents; and that pretest set points have been recorded.
3. Certify that plumbing procedures have been completed, and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
4. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.

5. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
6. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.
7. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable, or failed. Repeat this test for each operating cycle that applies to system being tested.
8. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
9. Annotate checklist or data sheet when a deficiency is observed.
10. Verify equipment interface with monitoring and control system and TAB criteria; include the following:

    a. Flow rates for domestic re-circulating systems.

    b. Discharge temperatures of water heaters.

    c. Re-circ. pump pressures and flow rates.

    d. Domestic water meter total volume in gallons.

    e. Flow rates in gallons per minute for showerheads.

    f. Trap priming station water discharge.

    g. Water heater temperatures and set points.

11. Verify proper responses of monitoring and control system controllers and sensors to include the following:

    a. For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device, check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on checklist or data sheet.
    b. Report deficiencies and prepare an issues log entry.

12. Verify that plumbing equipment field quality-control testing has been completed and approved. CxA shall direct, witness, and document field quality-control tests, inspections, and startup specified in individual Division 22 Sections.

13. Verify flow rates of all aerators.

14. Verify the operation of all plumbing fixtures.

B. Testing Instrumentation: Install measuring instruments and logging devices to record test data for the required test period. Instrumentation shall monitor and record full range of operating conditions and shall allow for calculation of total capacity of system for each mode of operation. Operational modes include the following:

1. Occupied and unoccupied.
2. Life-safety and safety systems.
3. Temporary upset of system operation.
4. Partial occupancy conditions.
5. Special cycles.
6. Alarm conditions.

3.02 TAB VERIFICATION

A. TAB Subcontractor shall coordinate with CxA for work required in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing." TAB Subcontractor shall copy CxA with required reports, sample forms, checklists, and certificates.

B. Contractor, Plumbing Contractor, and CxA shall witness TAB Work.

C. TAB Preparation:

1. TAB Subcontractor shall provide CxA with data required for "Pre-Field TAB Engineering Reports" specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."

    a. CxA shall use this data to certify that prestart and startup activities have been completed for systems, subsystems, and equipment installation.

D. Verification of Final TAB Report:

1. CxA shall select, at random, 10 percent of report for field verification.
2. CxA shall notify TAB Subcontractor 10 days in advance of the date of field verification; however, notice shall not include data points to be verified. The TAB Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item is defined as follows:

    a. A deviation of more than 10 percent.

4. Failure of more than 10 percent of selected items shall result in rejection of final TAB report.

E. If deficiencies are identified during verification testing, CxA shall notify the HVAC Contractor and Architect, and shall take action to remedy the deficiency. Architect shall review final tabulated checklists and data sheets to determine if verification is complete and that system is operating according to the Contract Documents.

F. CxA shall certify that TAB Work has been successfully completed.

3.03 TESTING

A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

B. Perform tests using design conditions whenever possible.

1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
2. Alter set points when simulating conditions is not practical and when written approval is received from CxA.
3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.

C. Scope of Plumbing Contractor Testing:

1. Testing scope shall include entire plumbing installation, from central hot water heating equipment for heat generation through distribution systems to each fixture. It shall include measuring capacities and effectiveness of operational and control functions.
2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
3. Test all plumbing fixtures.
4. Test time to reach temperature and temperature of hot water at all fixtures with thermostatic mixing valves.
5. Test discharge of water at all trap priming stations.
6. Verify that all backflow preventers have been tested. Document in writing.
7. Test operation of all water meters.
8. Test domestic water heaters.
9. Test water meters and interlock with ATC system.
10. Test operation, set points, and safeties of water heaters.

D. Detailed Testing Procedures: CxA, with Plumbing Contractor, TAB Subcontractor, and Plumbing Instrumentation and Control Contractor, shall prepare detailed testing plans, procedures, and checklists for plumbing systems, subsystems, and equipment.

E. HVAC Instrumentation and Control System Testing:

1. Field testing plans and testing requirements are specified in Division 23 Section "Instrumentation & Controls of HVAC & Plumbing Systems." The CxA, Plumbing Contractor, and the HVAC Instrumentation and Control Contractor shall collaborate to prepare testing plans.
2. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.

F. Plumbing System Testing: Plumbing Contractor shall prepare a testing plan to verify performance of water heaters, domestic re-circulating systems, backflow preventers, plumbing fixtures, trap priming stations, domestic pumps, domestic water meters, and thermostatic mixing valves. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings for

each pipe sector showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.

2. Tracking checklist for managing and ensuring that all pipe sections have been tested.
3. Design and actual measurements for all equipment.

G. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.
2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

H. Testing Reports:

1. Reports shall include measured data, data sheets, and a comprehensive summary describing the operation of systems at the time of testing.
2. Include data sheets for each controller to verify proper operation of the control system, the system it serves, the service it provides, and its location. For each controller, provide space for recording its readout, the reading at the controller's sensor(s), plus comments. Provide space for testing personnel to sign off on each data sheet.
3. Prepare a preliminary test report. Deficiencies will be evaluated by Architect to determine corrective action. Deficiencies shall be corrected and test repeated.

END OF SECTION

DIVISION 01
SECTION 01 91 15
HVAC COMMISSIONING REQUIREMENTS
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HVAC COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

A. This Section includes requirements for commissioning the HVAC system and its subsystems and equipment. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."

B. Related Sections include the following:

1. Division 01 Section "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section.

C. The following systems and/or equipment shall be commissioned:

1. Exhaust air systems.
2. HVAC controls and sequences of operation.
3. Manual overrides.
4. Automatic Temperature Control System.
5. Water meter/ATC interface.
6. Electric Heaters.

1.03 DEFINITIONS

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

B. CxA: Commissioning Authority.

C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

D. TAB: Testing, Adjusting, and Balancing.

1.04 CONTRACTOR'S RESPONSIBILITIES

A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Contractor:

1. Attend procedures meeting for TAB Work.
2. Certify that TAB Work is complete.

C. Mechanical Contractor:

1. Attend TAB verification testing.
2. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.

D. HVAC Instrumentation and Control Contractor: With the CxA, review control designs for compliance with the Contract Documents, controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions.

E. TAB Subcontractor:

1. Contract Documents Review: With the CxA, review the Contract Documents before developing TAB procedures.

a. Verify the following:

1) Accessibility of equipment and components required for TAB Work.
2) Adequate number and placement of duct balancing dampers to allow proper balancing while minimizing sound levels in occupied spaces.
3) Adequate number and placement of balancing valves to allow proper balancing and recording of water flow.
4) Adequate number and placement of test ports and test instrumentation to allow reading and compilation of system and equipment performance data needed to conduct both TAB and commissioning testing.
5) Air and water flow rates have been specified and compared to central equipment output capacities.

b. Identify discontinuities and omissions in the Contract Documents.
c. This review of the Contract Documents by the TAB Subcontractor satisfies requirements for a design review report as specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."

2. Additional Responsibilities: Participate in tests specified in Division 23 Sections "Instrumentation & Controls of HVAC & Plumbing Systems."

F. Electrical Contractor:

1. With the Mechanical Contractor, coordinate installations and connections between and among electrical and HVAC systems, subsystems, and equipment.
2. Attend TAB verification testing.

1.05 COMMISSIONING DOCUMENTATION

A. The following are in addition to documentation specified in Division 01 Section "General Commissioning Requirements."

B. Test Checklists: CxA with assistance of Contractor shall develop test checklists for HVAC systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. In addition to the requirements specified in Division 01 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:

1. Calibration of sensors and sensor function.
2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.
3. Control sequences for HVAC systems.
4. Strength of control signal for each set point at specified conditions.
5. Responses to control signals at specified conditions.
6. Sequence of response(s) to control signals at specified conditions.
7. Electrical demand or power input at specified conditions.
8. Power quality and related measurements.
9. Expected performance of systems, subsystems, and equipment at each step of test.
10. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.
11. Interaction of auxiliary equipment.
12. Issues log.

1.06 SUBMITTALS

A. The following submittals are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.

C. Certificate of Readiness: CxA shall compile certificates of readiness from Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

D. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed. Certification shall include completed checklists provided by TAB Subcontractor as specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."

E. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them in systems manual and commissioning report.

F. Corrective Action Documents: CxA shall submit corrective action documents.

G. Certified TAB Reports: CxA shall submit verified, certified TAB reports.

H. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

1.07 ALTERNATES

A. Refer to Division 01, -*Alternates* for description of work under this section affected by alternates.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 TESTING PREPARATION

A. Prerequisites for Testing:

1. Certify that HVAC systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the Contract Documents; and that Certificates of Readiness are signed and submitted.
2. Certify that HVAC instrumentation and control systems have been completed and calibrated; are operating according to the Contract Documents; and that pretest set points have been recorded.
3. Certify that TAB procedures have been completed, and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
4. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.
5. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
6. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.
7. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable, or failed. Repeat this test for each operating cycle that applies to system being tested.

8. Check safety cutouts, alarms, and interlocks with duct detectors and life-safety systems during each mode of operation.
9. Annotate checklist or data sheet when a deficiency is observed.
10. Verify equipment interface with monitoring and control system and TAB criteria; include the following:

    a. Manual override switches.
    b. Total exhaust airflow.
    c. Sequences of operation of all HVAC equipment.
    d. Electric heating equipment volts, amps, and temperature rise.

11. Verify proper responses of monitoring and control system controllers and sensors to include the following:

    a. For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device, check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on checklist or data sheet.
    b. Report deficiencies and prepare an issues log entry.

12. Verify that HVAC equipment field quality-control testing has been completed and approved. CxA shall direct, witness, and document field quality-control tests, inspections, and startup specified in individual Division 23 Sections.

B. Testing Instrumentation: Install measuring instruments and logging devices to record test data for the required test period. Instrumentation shall monitor and record full range of operating conditions and shall allow for calculation of total capacity of system for each mode of operation. For individual room cooling tests, provide temporary heaters to impose a cooling load. Operational modes include the following:

1. Heating Mode.
2. Occupied and unoccupied.
3. Fire safety.
4. Temporary upset of system operation.
5. Partial occupancy conditions.
6. Special cycles.

3.02 TAB VERIFICATION

A. TAB Subcontractor shall coordinate with CxA for work required in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing." TAB Subcontractor shall copy CxA with required reports, sample forms, checklists, and certificates.

B. Contractor, HVAC Contractor, and CxA shall witness TAB Work.

C. TAB Preparation:

1. TAB Subcontractor shall provide CxA with data required for "Pre-Field TAB Engineering Reports" specified in Division 23 Section "Testing Adjusting & Balancing for HVAC & Plumbing."

    a. CxA shall use this data to certify that prestart and startup activities have been completed for systems, subsystems, and equipment installation.

D. Verification of Final TAB Report:

1. CxA shall select, at random, 10 percent of report for field verification.
2. CxA shall notify TAB Subcontractor 10 days in advance of the date of field verification; however, notice shall not include data points to be verified. The TAB Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item is defined as follows:

    a. For all readings a deviation of more than 10 percent.

4. Failure of more than 10 percent of selected items shall result in rejection of final TAB report.

E. If deficiencies are identified during verification testing, CxA shall notify the HVAC Contractor and Architect, and shall take action to remedy the deficiency. Architect shall review final tabulated checklists and data sheets to determine if verification is complete and that system is operating according to the Contract Documents.

F. CxA shall certify that TAB Work has been successfully completed.

3.03 TESTING

A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

B. Perform tests using design conditions whenever possible.

1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
2. Alter set points when simulating conditions is not practical and when written approval is received from CxA.
3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.

C. Scope of HVAC Contractor Testing:

1. Testing scope shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. It shall include measuring capacities and effectiveness of operational and control functions.
2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. Detailed Testing Procedures: CxA, with HVAC Contractor, TAB Subcontractor, and HVAC Instrumentation and Control Contractor, shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.

E. HVAC Instrumentation and Control System Testing:

1. Field testing plans and testing requirements are specified in Division 23 Section "Instrumentation & Controls of HVAC & Plumbing Systems". The CxA, HVAC Contractor, Equipment Provider/Manufacturer and the HVAC Instrumentation and Control Contractor shall collaborate to prepare testing plans.
2. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.

F. Heat-Generation System Testing: HVAC Contractor shall prepare a testing plan to verify performance of exhaust fans, and unit heaters. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.

G. HVAC Distribution System Testing: HVAC Contractor shall prepare a testing plan to verify performance of air, exhaust, and other distribution systems. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.

H. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.
2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

I. Testing Reports:

1. Reports shall include measured data, data sheets, and a comprehensive summary describing the operation of systems at the time of testing.

2. Include data sheets for each controller to verify proper operation of the control system, the system it serves, the service it provides, and its location. For each controller, provide space for recording its readout, the reading at the controller's sensor(s), plus comments. Provide space for testing personnel to sign off on each data sheet.
3. Prepare a preliminary test report. Deficiencies will be evaluated by Architect to determine corrective action. Deficiencies shall be corrected and test repeated.

END OF SECTION

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SECTION 01 91 16

ELECTRICAL SYSTEMS COMMISSIONING REQUIREMENTS

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SECTION 01 91 16

ELECTRICAL SYSTEMS COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes requirements for commissioning the electrical system and its subsystems and equipment. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."

B. Related Sections include the following:

1. Division 01 Section "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section.

C. The following systems and/or equipment shall be commissioned.

1. Sports lighting.
2. Lighting control systems.
3. Electrical distribution system.
4. Communication systems.
5. Fire Alarm System.
6. Security System.
7. Exterior lighting and associated controls.
8. Electrical distribution system.
    a. Distribution panelboards.
    b. Safety/disconnect switches.
    c. Motor starters.
    d. Lighting contactors.
9. Communication systems.
    a. Data systems.
    b. Telephone/intercom.
10. Emergency Lighting.
11. Local AV Systems.

1.3 DEFINITIONS

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of electrical systems, electrical, communications, and other related systems.

B. CxA: Commissioning Authority.

C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Electrical Contractor:

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

C. Electrical Contractor:

1. With the Mechanical Contractor, coordinate installations and connections between and among electrical and HVAC systems, subsystems, and equipment.

2. Attend TAB verification testing.

1.5 COMMISSIONING DOCUMENTATION

A. The following are in addition to documentation specified in Division 01 Section "General Commissioning Requirements."

B. Test Checklists: CxA with assistance of Contractor shall develop test checklists for electrical systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. In addition to the requirements specified in Division 01 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:

1. Calibration of sensors and sensor function.

2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.

3. Control sequences for electrical systems.

4. Strength of control signal for each set point at specified conditions.

5. Responses to control signals at specified conditions.

6. Sequence of response(s) to control signals at specified conditions.

7. Electrical demand or power input at specified conditions.

8. Power quality and related measurements.
9. Expected performance of systems, subsystems, and equipment at each step of test.
10. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.
11. Interaction of auxiliary equipment.
12. Issues log.

1.6 SUBMITTALS

A. The following submittals are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.

C. Certificate of Readiness: CxA shall compile certificates of readiness from Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

D. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed.

E. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them in systems manual and commissioning report.

F. Corrective Action Documents: CxA shall submit corrective action documents.

1.7 ALTERNATES

A. Refer to Division 01, *-Alternates* for description of work under this section affected by alternates.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Prerequisites for Testing:

1. Certify that electrical systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the Contract Documents; and that Certificates of Readiness are signed and submitted.
2. Certify that electrical instrumentation and control systems have been completed and calibrated; are operating according to the Contract Documents; and that pretest set points have been recorded.

3. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.

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

5. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.

6. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable, or failed. Repeat this test for each operating cycle that applies to system being tested.

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

8. Annotate checklist or data sheet when a deficiency is observed.

9. Verify proper responses of monitoring and control system controllers and sensors to include the following:

   a. For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device, check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on checklist or data sheet.

   b. Report deficiencies and prepare an issues log entry.

3.2 TESTING

A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

B. Perform tests using design conditions whenever possible.

1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

C. Scope of Electrical Contractor Testing:

1. Testing scope shall include entire electrical installation, from incoming service through distribution systems to each space. It shall include measuring voltages and currents and effectiveness of operational and control functions.

2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. Detailed Testing Procedures: CxA, with Electrical Contractor shall prepare detailed testing plans, procedures, and checklists for electrical systems, subsystems, and equipment.

E. Electrical System Testing: Electrical Contractor shall prepare a testing plan to verify performance of emergency generator, lighting control systems, electrical distribution systems, communication systems, security systems, exterior lighting control systems, electrical distribution systems, fire alarm and voice evacuation system, stage lighting/dimming system. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of wiring to be tested, identified by identification marker. Markers shall be keyed to Drawings for each wiring sector showing the physical location of each item of equipment and electrical wiring test section. Drawings shall be formatted to allow each item of equipment and section of wiring to be physically located and identified when referred to in the system testing plan.
2. Tracking checklist for managing and ensuring that all wiring systems have been tested.

F. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the electrical system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.
2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

G. Testing Reports:

1. Reports shall include measured data, data sheets, and a comprehensive summary describing the operation of systems at the time of testing.
2. Include data sheets for each electrical systems to verify proper operation of the electrical systems, the system it serves, the service it provides, and its location. Provide space for testing personnel to sign off on each data sheet.
3. Prepare a preliminary test report. Deficiencies will be evaluated by Architect to determine corrective action. Deficiencies shall be corrected and test repeated.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Refer to Scope Information Sheets for this contract bound in the Project Manual under Section 01 1000, Summary of Work. The Scope Information Sheets describe generally the work included in each contract, but the work is not necessarily limited to that described.

B. Concrete formwork.

C. Floors and slabs on grade.

D. Concrete foundations.

E. Concrete reinforcement.

F. Joint devices associated with concrete work.

G. Concrete curing.

1.02 REFERENCE STANDARDS

A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; American Concrete Institute International; 2010.

B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2002).

C. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete; American Concrete Institute International; 1998 (Reapproved 2004).

D. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2010.

E. ACI 302.1R - Guide for Concrete Floor and Slab Construction; American Concrete Institute International; 2004 (Errata 2007).

F. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.

G. ACI 305R - Hot Weather Concreting; American Concrete Institute International; 2010.

H. ACI 306R - Cold Weather Concreting; American Concrete Institute International; 2010.

I. ACI 308R - Guide to Curing Concrete; American Concrete Institute International; 2001 (Reapproved 2008).

J. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2008.

K. ACI 347 - Guide to Formwork for Concrete; American Concrete Institute International; 2004.

L. ASTM A185/A185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.

M. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2012.

N. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2011a.

O. ASTM C150/C150M - Standard Specification for Portland Cement; 2012.

P. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2007.

Q. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete; 2009.

R. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2012.

S. ASTM E1155 - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers; 1996 (Reapproved 2008).

T. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2011.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.

C. Samples: Submit samples of underslab vapor retarder to be used.

D. LEED Submittal: If any fly ash, ground granulated blast furnace slag, silica fume, rice hull ash, or other waste material is used in mix designs to replace Portland cement, submit the total volume of concrete cast in place, mix design(s) used showing the quantity of portland cement replaced, reports showing successful cylinder testing, and temperature on day of pour if cold weather mix is used; use LEED New Product Content Form.

E. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.04 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 301 and ACI 318.

B. Follow recommendations of ACI 305R when concreting during hot weather.

C. Follow recommendations of ACI 306R when concreting during cold weather.

PART 2 PRODUCTS

2.01 FORMWORK

A. Formwork Design and Construction: Comply with guidelines of ACI 347 to provide formwork that will produce concrete complying with tolerances of ACI 117.

B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.

2.02 REINFORCEMENT

A. Reinforcing Steel: ASTM A615/A615M Grade 60 (420).

B. Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain type.
   1. Form: Flat Sheets.
   2. Mesh Size and Wire Gage: As indicated on drawings.

C. Reinforcement Accessories:
   1. Tie Wire: Annealed, minimum 16 gage.
   2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of

reinforcement during concrete placement.

2.03 CONCRETE MATERIALS

A. Cement: ASTM C150, Type I - Normal Portland type.

B. Fine and Coarse Aggregates: ASTM C 33.

C. Lightweight Aggregate: ASTM C 330.

D. Fly Ash: ASTM C618, Class C or F.

E. Water: Clean and not detrimental to concrete.

2.04 ACCESSORY MATERIALS

A. Underslab Vapor Retarder: Multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. The use of single ply polyethylene is prohibited.
   1. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations in vapor retarder.
   2. Products:
      a. Insulation Solutions, Inc; Viper VaporCheck II 15-mil (Class A): www.insulationsolutions.com.
      b. Stego Industries, LLC; Stego Wrap Vapor Barrier 15-mil (Class A): www.stegoindustries.com.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

B. Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.

C. Moisture-Retaining Cover: ASTM C 171; regular curing paper, clear polyethylene, or white burlap-polyethylene sheet.

2.05 BONDING AND JOINTING PRODUCTS

A. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.

2.06 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
   1. Replace as much Portland cement as possible with fly ash, ground granulated blast furnace slag, silica fume, or rice hull ash as is consistent with ACI recommendations.

B. Proportioning Structural Lightweight Concrete: Comply with ACI 211.2 recommendations.
   1. Replace as much Portland cement as possible with fly ash, ground granulated blast furnace slag, silica fume, or rice hull ash as is consistent with ACI recommendations.

C. Concrete Strength: Establish required average strength for each type of concrete on the basis of trial mixtures, as specified in ACI 301.
   1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

D. Normal Weight Concrete:
   1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 3,000 psi.

E. Structural Lightweight Concrete:
   1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days:

3,000 psi.

PART 3 EXECUTION

3.01 PREPARATION

A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.

B. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.

3.02 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

A. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.

B. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.

3.03 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

B. Place concrete for floor slabs in accordance with ACI 302.1R.

C. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.04 SLAB JOINTING

A. Locate joints as indicated on the drawings.

B. Anchor joint fillers and devices to prevent movement during concrete placement.

C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.

3.05 FLOOR FLATNESS AND LEVELNESS TOLERANCES

A. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:
   1. Exposed to View and Foot Traffic: F(F) of 20; F(L) of 15, on-grade only.
   2. Under Thin Resilient Flooring and Thinset Tile: F(F) of 35; F(L) of 25, on-grade only.

B. Measure F(F) and F(L) in accordance with ASTM E1155, within 48 hours after slab installation; report both composite overall values and local values for each measured section.

C. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than F(F) 13/F(L) 10.

D. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.06 CONCRETE FINISHING

A. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
   1. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI 301.1R; thin floor coverings include carpeting, resilient flooring, and seamless flooring.
   2. Other Surfaces to Be Left Exposed: "Steel trowel" as described in ACI 302.1R, minimizing burnish marks and other appearance defects.

3.07 CURING AND PROTECTION

A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

C. Surfaces Not in Contact with Forms:
   1. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
   2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-fog spray, or saturated burlap.
   3. Final Curing: Begin after initial curing but before surface is dry.
      a. Moisture-Retaining Cover: Seal in place with waterproof tape or adhesive.

3.08 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00.

B. Provide free access to concrete operations at project site and cooperate with appointed firm.

C. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

3.09 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.10 PROTECTION

A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Refer to Scope Information Sheets for this contract bound in the Project Manual under Section 01 1000, Summary of Work. The Scope Information Sheets describe generally the work included in each contract, but the work is not necessarily limited to that described.

B. Structural steel framing members, support members.

C. Base plates, shear stud connectors and expansion joint plates.

D. Grouting under base plates.

1.02 RELATED REQUIREMENTS

A. Section 05 21 00 - Steel Joist Framing.

B. Section 05 31 00 - Steel Decking: Support framing for small openings in deck.

1.03 REFERENCE STANDARDS

A. AISC (MAN) - Steel Construction Manual; American Institute of Steel Construction, Inc.; 2005.

B. AISC S303 - Code of Standard Practice for Steel Buildings and Bridges; American Institute of Steel Construction, Inc.; 2005.

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2008.

D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

E. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished; 2007.

F. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

G. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength; 2010.

H. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2010.

I. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2009.

J. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2007.

K. ASTM A514/A514M - Standard Specification for High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding; 2005 (Reapproved 2009).

L. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2011.

M. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2011.

N. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners; 2009.

O. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2007.

P. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2010.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:
1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
2. Connections not detailed.
3. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.

C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.05 QUALITY ASSURANCE

A. Fabricate structural steel members in accordance with AISC "Steel Construction Manual."

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Angles and Plates: ASTM A36/A36M.

B. Rolled Steel Structural Shapes: ASTM A992/A992M.

C. Hot-Formed Structural Tubing: ASTM A501, seamless or welded.

D. Steel Bars: ASTM A108.

E. Steel Plate: ASTM A514/A514M.

F. Pipe: ASTM A53/A53M, Grade B, Finish black.

G. Shear Stud Connectors: Made from ASTM A 108 Grade 1015 bars.

H. Structural Bolts and Nuts: Carbon steel, ASTM A307, Grade A galvanized to ASTM A 153/A 153M, Class C.

I. High-Strength Structural Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1, medium carbon, galvanized.

J. Load Indicator Washers: Provide washers complying with ASTM F959 at all connections requiring high-strength bolts.

K. Welding Materials: AWS D1.1; type required for materials being welded.

L. Grout: Non-shrink, non-metallic aggregate type, complying with ASTM C1107/C1107M and capable of developing a minimum compressive strength of 7,000 psi at 28 days.

M. Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

N. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

A. Shop fabricate to greatest extent possible.

B. Continuously seal joined members by continuous welds. Grind exposed welds smooth.

C. Fabricate connections for bolt, nut, and washer connectors.

PART 3 EXECUTION

3.01 ERECTION

A. Erect structural steel in compliance with AISC "Code of Standard Practice for Steel Buildings and Bridges".

B. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

3.02 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

END OF SECTION

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Exterior non-load-bearing wall framing.
2. Roof rafter framing.
3. Ceiling joist framing.
4. Soffit framing.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for masonry shelf angles and connections.
2. Section 092216 "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.
3. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cold-formed steel framing product and accessory.

B. LEED Submittals:

1. Product Data for Credit MR 4: 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.

C. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.

2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Clark Western Building Systems, Inc.
2. Design Shapes in Steel.
3. Dietrich Metal Framing; a Worthington Industries Company.
4. Marino/WARE.
5. Olmar Supply, Inc.
6. Quail Run Building Materials, Inc.
7. Steel Construction Systems.
8. Telling Industries, LLC.
9. The Steel Network, Inc.
10. United Metal Products, Inc.
11. United Steel Manufacturing

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

    a. Interior Load-Bearing Wall Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft. (239 Pa).
    b. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/360, 1/600 for masonry veneer of the wall height.

3. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Design Standards:

1. Wall Studs: AISI S211.
2. Headers: AISI S212.
3. Lateral Design: AISI S213.

D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

B. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.
2. Coating: G60 (Z180), A60 (ZF180)..

C. Steel Sheet for Vertical Deflection or Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 33 (230).
2. Coating: G60 (Z180).

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
2. Flange Width: 1-5/8 inches (41 mm).

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
2. Flange Width: 1-1/4 inches (32 mm).

C. Vertical Deflection Clips: Manufacturer's standard bypass or heaclips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

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. AllSteel & Gypsum Products, Inc.
b. ClarkWestern Bulding Systems, Inc.
c. Dietrich Metal Framing; a Worthington Industries Company.
d. Marino/WARE.
e. SCAFCO Corporation
f. Steeler, Inc.
g. The Steel Network, Inc

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement,

with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm).
2. Flange Width: 1 inch (25 mm) plus the design gap for 1-story structures.

2.5 ROOF-RAFTER FRAMING

A. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm).
2. Flange Width: 1-5/8 inches (41 mm) minimum.

2.6 CEILING JOIST FRAMING

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with standard holes,]with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm.
2. Flange Width: [1-5/8 inches (41 mm) minimum.

2.7 SOFFIT FRAMING

A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
2. Flange Width: 1-5/8 inches (41 mm), minimum.

2.8 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Stud kickers and knee braces.
8. Hole reinforcing plates.
9. Backer plates.

2.9 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated in accordance with ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.10 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780.

B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.

D. Shims: Load bearing, high-density multimonomer plastic, nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.3 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to bottom track, unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As indicated.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Connect vertical deflection clips to bypassing studs and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.

1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches (450 mm) of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

a. Install solid blocking at 96-inch (2440-mm) centers.

2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.4 JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.

C. Space joists not more than 2 inches (51 mm) from abutting walls, and as follows:

1. Joist Spacing: As indicated.

D. Frame openings with built-up joist headers consisting of joist and joist track, or another combination of connected joists if indicated.

E. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:
1. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

F. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.5 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 054400 - COLD-FORMED METAL TRUSSES

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. Cold-formed steel trusses for roofs.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for cold-formed steel studs, joists, and rafters.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit MR 4: 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.

C. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel trusses; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
3. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Shop Drawings: At the start of construction, the Architect's consulting structural engineer will provide an electronic file of their review stamp to be placed by the shop drawing preparer near the bottom right corner of each shop drawing submitted.

E. Delegated-Design Submittal: For cold-formed steel trusses.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Miscellaneous structural clips and accessories.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

D. Professional Engineer Qualifications: A Professional Engineer who is legally qualified to practice in jurisdiction where project ifs located and who is experienced in providing engineering services of the kind indicated

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel trusses from corrosion, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Aegis Metal Framing.
2. Genesis Worldwide Inc.
3. Marino/WARE.
4. Nuconsteel, A Nucor Company.
5. Steel Construction Systems.
6. TrusSteel; an ITW company.
7. USA Frametek.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel trusses capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated.
2. Deflection Limits: Design trusses to withstand design loads without deflections greater than the following:

a. Roof Trusses: Vertical deflection of 1/360 of the span.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

C. Cold-Formed Steel Framing Design Standards:

1. Lateral Design: Design according to AISI S213.
2. Roof Trusses: Design according to AISI S214.

D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL TRUSS MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

B. Steel Sheet: ASTM A 1003, structural grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: ST33H or as required by structural performance.
2. Coating: G60.

2.4 ROOF TRUSSES

A. Roof Truss Members: Manufacturer's standard C-shaped steel sections.

1. Connecting Flange Width: 1-5/8 inches minimum at top and bottom chords connecting to sheathing or other directly fastened construction.
2. Minimum Base-Metal Thickness: 0.0329 inch.

2.5 ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003, structural grade, Type H, metallic coated, of same grade and coating weight used for truss members.

B. Provide accessories of manufacturer's standard thickness and configuration unless otherwise indicated.

2.6 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and Appendix D in ACI 318, greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.

D. Power-Actuated Fasteners: Fastener system of type suitable for application, fabricated from corrosion-resistant materials, with capability to sustain, without failure, allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B , VOC compliant.

B. Shims: Load bearing, of high-density multimonomer plastic, nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

2.8 FABRICATION

A. Fabricate cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate trusses using jigs or templates.
2. Cut truss members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.

    a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

4. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting cold-formed steel trusses for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed steel trusses without reducing thickness of fire-resistive materials below that is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION

A. Install, bridge, and brace cold-formed steel trusses according to AISI S200, AISI S214, AISI's "Code of Standard Practice for Cold-Formed Steel Structural Framing," and manufacturer's written instructions unless more stringent requirements are indicated.

B. Install cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened.

1. Fasten cold-formed steel trusses by welding or mechanical fasteners.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners and install according to Shop Drawings; comply with requirements for spacing, edge distances, and screw penetration.

C. Install temporary bracing and supports. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

D. Truss Spacing: As indicated.

E. Do not alter, cut, or remove framing members or connections of trusses.

F. Erect trusses with plane of truss webs plumb and parallel to each other, align, and accurately position at spacings indicated.

G. Erect trusses without damaging framing members or connections.

H. Coordinate with wall framing to align webs of bottom chords and load-bearing studs or continuously reinforce track to transfer loads to structure. Anchor trusses securely at all bearing points.

I. Install continuous bridging and permanently brace trusses as indicated on Shop Drawings and designed according to CFSEI's TechNote 551e, "Design Guide: Permanent Bracing of Cold-Formed Steel Trusses.".

J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections indicated on structural drawings.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Field and shop welds will be subject to testing and inspecting.

D. Prepare test and inspection reports.

3.5 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal trusses are without damage or deterioration at time of Substantial Completion.

END OF SECTION 054400

SECTION 07 84 13
HVAC & PLUMBING PENETRATION FIRESTOPPING
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SECTION 07 84 13

HVAC & PLUMBING PENETRATION FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

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

B. Section includes:

1. Through-penetration firestopping in fire rated construction.

2. Through-penetration smoke-stopping in smoke partitions.

C. Related items:

1. Fire dampers and manufactured devices: Refer to Division 23 Section *HVAC Air Distribution*.

2. Smoke dampers and combination fire/smoke dampers. Refer to Division 23 Section *HVAC Air Distribution*.

1.02 REFERENCES

A. Underwriters Laboratories

1. UL Fire Resistance Directory

a. Through-penetration firestop devices (XHCR)

b. Fire resistance rating (BXUV)

c. Through-penetration firestop systems (XHEZ)

d. Fill, void, or cavity material (XHHW)

B. American Society for Testing and Materials Standards:

1. ASTM E 814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.

1.03 DEFINITIONS

A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.

B. Barriers: Time-rated fire walls, smoke barrier walls, time-rated ceiling/floor assemblies and structural floors.

C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.

D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.

E. System: Specific products and applications, classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.

F. Sleeve: Metal fabrication or pipe section extended through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

1.04 SYSTEM DESCRIPTION

A. Design Requirements

1. Fire-rated construction: Maintain barrier and structural floor fire resistance ratings including resistance to cold smoke at all penetrations.

2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations.

1.05 SUBMITTALS

A. Submit in accordance with Division 01 Section *Submittal Procedures*, unless otherwise indicated.

B. Product data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.

2. Manufacturer's installation instructions.

C. Shop drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.

1. Details of each proposed assembly identifying intended products and applicable UL system number, or UL classified devices.

2. Manufacturer or manufacturer's representative shall provide qualified engineering judgment and drawings relating to non-standard applications as needed.

D. Quality control submittals:

1. Statement of qualifications.

E. Applicators' qualifications statement:

1. List past projects indicating required experience.

1.06 QUALITY ASSURANCE

A. Installer's qualifications: Fire experienced in installation or application of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, State or local authority where applicable.

2. At least 2 years experience with systems.

3. Successfully completed at least 5 comparable scale projects using this system.

B. Local and State regulatory requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System numbers, or UL classified devices.

C. Materials shall have been tested to provide fire rating at least equal to that of the construction.

D. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:

1. Deliver products in original unopened packaging with legible manufacturer's identification.

2. Coordinate delivery with scheduled installation date, allow minimum storage at site.

B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer's instructions.

1.08 PROJECT CONDITIONS

A. Existing condition:

1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

B. Environmental requirements:

1. Furnish adequate ventilation if using solvent.

2. Furnish forced air ventilation during installation if required by manufacturer.

3. Keep flammable materials away from sparks or flame.

4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.

1.09 WARRANTY

A. Submit copies of written warranty agreeing to repair or replace joint sealers which fail in joint adhesion, extrusion resistance, migration resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The warranty period shall be two (2) years from date of substantial completion unless otherwise noted.

PART 2 PRODUCTS

2.01 THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Systems of devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetrant type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the UL system or device, and designed to perform this function.

2. Acceptable manufacturers and products.

a. Those listed in the UL Fire Resistance directory for the UL System involved and as further defined in the System and Applications Schedule in Part 3.6 of this section.

3. All firestopping products must be from a single manufacturer. All trades shall use products from the same manufacturer unless otherwise noted.

2.02 SMOKE-STOPPING AT SMOKE PARTITIONS

A. Through-penetration smoke-stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction, as specified in The Systems and Applications Schedule in Part 3.6 of this section, is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.03 ACCESSORIES

A. Fill, void or cavity materials: As classified under category XHHW in the UL Fire Resistance Directory.

B. Forming materials: As classified under category XHKU in the UL Fire Resistance Directory.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.

2. Do not proceed until unsatisfactory conditions have been corrected.

B. Coordinate an inspection of all Mechanical Firestopping systems with the Fire Marshal prior to installation of ceilings, walls, etc.

3.02 PREPARATION

A. Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.03 INSTALLATION

A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.

B. Seal holes or voids made by penetrations to ensure an effective smoke barrier.

C. Protect materials from damage on surfaces subject to traffic.

D. When large openings are created in walls or floors to permit installation of pipes, ducts, or other items, close unused portions of opening with firestopping materials tested for the application. See UL Fire Resistance Directory or Section 3.6 of this document.

E. Install smoke stopping as specified for firestopping.

3.04 FIELD QUALITY CONTROL

A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Perform under this section patching and repairing of firestopping caused by cutting or penetration by other trades.

3.05 ADJUSTING AND CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim materials as required.

C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.06 SYSTEMS AND APPLICATION SCHEDULES*

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Metal Pipe	CAJ1001 CP25S/L, CP25N/S CAJ1006 CS-195+, FS-195+ CAJ1007 FS-195+, 1-inch& 2-inch Wide CAJ1009 2000, 2000+, 2003 CAJ1010 2000, 2000+, 2003 CAJ1012 2000, 2000+, 2003 CAJ1013 2000, 2000+, 2003 CAJ1014 2000, 2000+, 2003 CAJ1015 2000, 2000+, 2003 CAJ1017 FD 150 CAJ1021 FD 150 CAJ1027 MPS-2+ CAJ1044 CP 25WB+ CAJ1052 CP 25S/L, CP 25N/S CAJ1058 2000, 2000+, 2003 CAJ1060 2000, 2000+, 2003 CAJ1063 2000, 2000+, 2003 CAJ1066 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1091 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1092 CP 25WB+ CAJ1112 FS-195+ CAJ1160 CP 25S/L, CP 25N/S CAJ1175 CP 25WB+ CAJ1176 CP 25WB+ CAJ1188 2000+ CBJ1020 CS-195+, FS-195+ CBJ1021 CS-195+, MPS-2+ CBJ1031 2001 CBJ1032 2001 FA1002 CP 25WB+ WJ1010 CP25WB+ WJ1023 2001	WL1001 CP 25 WL1002 FS-195+ WL1003 CP 25WB+,CP 25N/S WL1008 2000+ WL1009 2000+ WL1010 2000+ WL1016 CP 25WB+ WL1017 CP 25WB+,CP 25N/S WL1032 CP 25WB+,CP 25N/S WL1036 FD 150 WL1037 CS-195+,FS-195+ WL1067 CP 25N/S WL1073 CP 25WB+ WL1080 MPS2+ WL1082 2000+	FC1002 CP 25 FC1003 2000,2000+,20003 FC1006 CP 25WB+
Non-Metallic	CAJ2001 FS-195+, 1-inch& 2-inch WIDE, PPD'S CAJ2002 FS-195+ CAJ2003 CS-195+, FS-195+ CAJ2005 FS-195 CAJ2006 FS-195+ CAJ2013 FS-195+ CAJ2019 2000, 2000+, 2003 CAJ2027 FS-195+, CP 25N/S, CP 25S/L, CP 25WB+ CAJ2028 FS-195, MPS-2+ CAJ2029 FS-195+, PPD'S CAJ2030 CS-195+, FS-195+ CAJ2040 FS-195+, CP 25WB+ CAJ2044 FS-195+, CP 25N/S, CP 25S/L CP 25 WB+ CAJ2090 FS-195+ CAJ2177 FS-195+, PPD'S FA2001 FS-195+, PPD'S FS2002 CS-195+, FS-195+, MPS-2+, PPD'S FA2011 FS-195+ WJ2012 FS-195+ 1-inch WIDE	WL2002 FS-195+, PPD'S WL2003 FS-195+ WL2004 FS-195+ WL2005 FS-195+ 4' WIDE WL2006 FS-195+ WL2013 FS-195+ WL2031 CS-195+, FS-195+ WL2032 CS-195+, FS-195+ WL2033 FS-195+ WL2073 FS-195+ 1-inch WIDE	FC2002 FS-195+, PPD'S FC2007 FS-195+, PPD'S FC2008 FS-195+ FC2009 FS-195+, PPD'S FC2024 FS-195 FC2026 FS-195+ FC2028 FS-195, 1' & 2-inch WIDE, PPD'S

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Insulated Metallic Pipe	CAJ5001 CP 25N/S, CP 25S/L, CP 25WB+ CAJ5002 FS-195+ CAJ5003 FS-195+ CAJ5005 MPS-2+ CAJ5009 2000+, 2003 CAJ5017 FS-195+, CP 25 CAJ5022 FS-195+ CAJ5024 FS-195+ CAJ5030 CS-195+, FS-195+ CAJ5041 2000, 2000+, 2003 CAJ5060 CP 25WB+ CAJ5074 2000+ CBJ5002 CP 25 CBJ5003 FS-195+ FA5001 FS-195+, CP 25WB+	WL5001 FS-195+ WL5002 FS-195+ WL5009 FS-195+ WL5010 FS-195+ WL5011 CP 25WB+ WL5032 2000+ WL5038 CP 25WB+ WL5039 CP 25WB+ WL5040 CP 25WB+ WL5045 CP 25WB+ WL5053 2000+	FC5002 FS-195+ FC5008 FS-195+
Miscellaneous Mechanical HVAC Ducts	CAJ7001 CP 25N/S CP 25S/L CAJ7003 CP 25WB+ CAJ7009 DUCT WRAP, BULK PUTTY		FC7001 CP 25S/L, CP 25N/S
Mixed Penetrating Items Combos	CAJ8001 CS-195+ FS-195 CAJ8003 2000, 2000+, 20003 CAJ8004 2000, 2000+, 20003 CAJ8006 2001 CAJ8013 FS-195+, CP 25 CBJ8004 CS-195, FS-195+ CBJ8005 CS-195+, MPS-2+ CBJ8008 2001 FA8001 FS-195+, CP 25WB+	WL8002 CS-195+, FS-195+	

* Underwriter's Laboratories, Inc., Fire Resistance Directory.

END OF SECTION

SECTION 129300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:
   1. Benches
   2. Trash and Litter Receptacles
   3. Recycling Receptacles
   4. Bicycle Racks
   5. Flagpoles

B. Related Sections:
   1. Division 3 Section " Cast in Place Concrete"
   2. Division 26 Section "Exterior Electrical"

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, including assembly and installation instructions.

B. Samples for Color Verification: For units with factory-applied color finishes (bench, picnic tables, trash and recycling receptacles, bicycle racks, trail bollards and bollard and chain barrier).

C. Product Schedule: For site furnishings. Use same designations indicated on Drawings.

D. Maintenance Data: For site furnishings to include in maintenance manuals.

1.3 QUALITY ASSURANCE

A. Obtain site furnishings from specified sources.

B. Installer qualifications:
   1. Site furniture to be installed by manufacturer's Certified Installer whose work has resulted in construction of at least five similar installations, with a record of successful in-service performance for at least three years.

1.4 DELIVERY, STORAGE AND HANDLING

A. Protect all site furniture during storage and construction against rain, snow or ground water, and against soiling or contamination from earth and other materials.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Contractor to verify quantity on plans.

B. Bench:
1. Landscapeforms, Kalamazoo, MI, contact Barbara Nolan Inc, Tracey Friedly 410-951-9090
2. Model: Scarborough
3. Backed horizontal strap with one intermediate arm rest
4. Length – 8’-0”
5. Surface mount.
6. Color: Titanium powdercoat.

C. Trash Receptacles:
1. Quantity: 24
2. Landscapeforms, Kalamazoo, MI
3. Scarborough Series, Side-opening style with vertical strap side panels
4. Surface Mount
5. Color: Titanium powdercoat.

D. Recycling Receptacles:
1. Quantity: 12
2. Landscapeforms, Kalamazoo, MI
3. Scaroborough Series, Side-opening style, single use recycling opening
4. Signage by mfr. – Type 09 (Bottles/Cans)
5. Surface Mount
6. Color: Titanium powdercoat.

E. Bicycle Rack
1. Creative Pipe Inc., 1-800-644-8467
2. Inverted ‘U’ Bike Rack
3. Model: SU-20EP, embedded mount, capacity 2 bikes.
4. Color: Metallic Silver

F. Flagpoles
   1. Flagpole Warehouse, 1-800-962-0956
   2. Architectural Series Internal Halyard flagpoles
   3. Model: EC30IH, 33’-0” overall height (30’-0” exposed height) – qty.: 4
   4. Model: EC40IH, 44’-” overall height (40’-0” exposed height) – qty.: 2
   5. Aluminum, satin finish

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Install site furnishings as per manufacturer’s recommendations and details shown in these documents. Provide electrical service where required per manufacturer’s specifications.

B. Do not install any materials with chips, cracks, discolorations and other defects that would cause visible discoloration on the finished work.

C. Stake out all locations of site furniture for approval Architect prior to installation and anchoring.

D. Site furnishings as appropriately noted shall be permanently anchored as required by the drawings and manufacturer’s recommendations.

E. Install all products plumb and level.

F. Install footings as per specifications and as required by manufacturer’s specs, structural drawings and specifications.

END OF SECTION 129300

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SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1. GENERAL

1.01. SUMMARY

A. All work under Division 22 is subject to the Division 01, *General Requirements, the General Conditions and Supplementary Conditions.*

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all plumbing work.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.

D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* specified below. The right is reserved to make reasonable changes in location of equipment, piping, up to the time of rough-in or fabrication.

E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

F. Coordinate the work under Division 22 with the work of all other construction trades.

G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

1.02. PERMITS AND FEES

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

B. Permits and fees shall comply with the Division 01, *General Requirements* of the specification.

1.03. EXAMINATION OF SITE

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

B. Examine and verify specific conditions described in individual specifications sections.

C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.04. CONTRACTOR QUALIFICATION

A. Any Contractor or Subcontractor performing work under Division 22 shall be fully qualified and acceptable to the Architect and Owner. Submit the following evidence when requested:

1. A list of not less than five comparable projects which the Contractor completed.

2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.

3. Local and/or State License, where required.

4. Membership in trade or professional organizations where required.

B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.

C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.05. MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

D. Substitution will not be permitted for specified items of material or equipment where noted.

E. All items of equipment furnished shall have a service record of at least five (5) years.

1.06. FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.07. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

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

B.	ASHRAE	-	American Society of Heating, Refrigerating and Air Conditioning Engineers
C.	ASME	-	American Society of Mechanical Engineers
D.	ASPE	-	American Society of Plumbing Engineers
E.	ASTM	-	American Society for Testing and Materials
F.	AWWA	-	American Water Works Association
G.	DNREC	-	Delaware Department of Natural Resources and Environmental Control
H.	IBC	-	International Building Code
I.	IEEE	-	Institute of Electrical and Electronics Engineers
J.	MSSP	-	Manufacturers Standards Society of the Valve and Fittings Industry
K.	NEC	-	National Electrical Code
L.	NEMA	-	National Electrical Manufacturers Association
M.	NSF	-	National Sanitation Foundation
N.	UL	-	Underwriters' Laboratories

O. All plumbing equipment and materials shall comply with the codes and standards listed in the latest edition of ASHRAE HVAC Applications Handbook, Chapter entitled *Codes and Standards*.

1.08. SUBMITTALS, REVIEW AND ACCEPTANCE

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect to be in best interest of Owner.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product

that is regional. See Division 01 Sections related to LEED.

1.09. SHOP DRAWINGS

A. Prepare and submit shop drawings for all plumbing equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.

B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.

C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

D. Items and Systems

Access Doors/Panels including layout and location
Automatic Temperature Control System and Equipment as it relates to plumbing system
Backflow Preventers
Coordinated Drawings
Direct Buried Piping
Domestic Water Expansion Tanks
Domestic Water Heaters
Drip Pans
Fire Stopping - Methods and Materials
Floor and Roof Drains
Hose Bibbs and Wall Hydrants
Identification System
In-Line Circulators
Material and Equipment List
Operations and Maintenance Manuals
Pipe Materials Including Itemized Schedule
Plumbing Fixtures & Trim
Preliminary Testing and Balancing Report
Pressure Relief Valves
Schrader Fitting Valves
Test Certificates
Thermal Insulation Materials Include Table Summary
Thermometers and Gauges
Thermostatic Mixing Valves
Trap Priming Stations
Valves
Water Meters
Wiring Diagrams, Flow Diagrams and Operating Instructions

E. Contractor, additionally, shall submit for review any other shop drawings as required by the Architect. No item shall be delivered to the site, or installed, until the Contractor has received a submittal from the Engineer marked *Reviewed* or *Comments Noted*. After the

proposed materials have been reviewed, no substitution will be permitted except where approved by the Architect.

1.10. CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division 22. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect or Engineer.

1.11. PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where plumbing vents or other pipes penetrate roofs, flash pipe with Stoneman *Stormtite,* Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.

C. Furnish and install pitch pockets or weather tight curb assemblies where required.

D. Furnish and install roof drains, curbs, and vent assemblies specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer’s instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

1.12. CONCRETE AND MASONRY WORK

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 22. Perform work in accordance with requirements of other applicable Divisions of these specifications.

B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

1.13. EXCAVATION AND BACKFILLING

A. GENERAL

1. Perform all necessary excavation, or installation of work under Division 22, in

whatever materials or conditions encountered, using suitable methods and equipment.

2. Accurately establish required lines and grades and properly locate the work.

3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.

2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, and OSHA Guidelines.

3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the specifications)

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.

2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.

3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.

4. Do not backfill against frozen material. Do not use frozen material for backfill.

1.14. VIBRATION ISOLATION

A. Furnish and install vibration isolators, flexible connections, supports, anchors and/or foundations required to prevent transmission of vibration from equipment, or piping to building structure. See Division 23 Section, *Vibration Controls for HVAC, Plumbing and Fire Protection.*

1.15. ALTERNATES

A. Refer to Division 01 Section, “Alternates” for description of work under this section affected by alternates.

1.16. FASTENERS

A. All fasteners located in public spaces including locker rooms, corridors, lobbies, etc., shall be provided with tamper proof fasteners. Provide Pin Phillips hardware as manufactured by Challenge Industries or approved equal.

1.17. DEFINITIONS

A. *Approve* - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.

B. *Furnish and install* or *provide* means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

C. *Contractor* means the mechanical contractor and any of his subcontractors, vendors, suppliers, or fabricators.

D. *Piping* includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.

E. *Concealed* means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or attic.

F. *Exposed* means not installed underground or *concealed* as defined above.

G. *Invert Elevation* means the elevation of the inside bottom of pipe.

H. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.

I. *Review* - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

J. *Building Line:* Exterior wall of building.

1.18. MINIMUM EFFICIENCY REQUIREMENTS

A. All plumbing equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

B. All piping and equipment insulation shall comply with ASHRAE Standard 90.1, latest edition.

C. All service water/heating equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

D. All plumbing devices, controls, accessories, and components shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

1.19. LEED REQUIREMENTS

A. Refer to Division 01 Section, “LEED Requirements” for description of work under this Division affected by LEED requirements.

1.20. LEED SUBMITTALS

A. Product data for Credit EQ 4.1: For adhesives, welding solvents, and sealants applied within the building water proofing envelope, documentation including printed statement of VOC content in g/L.

B. Product data for Credit EQ 4.2: For paints and coatings applied within the building water proofing envelope, documentation including printed statement of VOC content in g/L.

1.21. SYSTEM INTEGRATION

A. For all plumbing equipment specified to be provided with packaged controls and interfaced with the automatic temperature control system, provide system integration between the equipment manufacturer and the automatic temperature control subcontractor.

B. Plumbing equipment submittals requiring system integration as defined above must identify all required system integration points.

C. Plumbing equipment manufacturers must coordinate with ATC subcontractor regarding system integration prior to submitting on the equipment.

D. A system integration meeting must be arranged by the Mechanical Contractor and include, but not be limited to the systems integrator for the plumbing equipment manufacturer and the ATC Subcontractor. This portion of systems integration must occur prior to plumbing equipment being delivered to the project.

E. Once the plumbing equipment is on site, a second systems integration meeting must be arranged by the Mechanical Contractor to coordinate the packaged controls with the ATC system. The plumbing equipment manufacturer's representative familiar with system integration and the ATC subcontractor familiar with programming must be present.

F. A final system integrations meeting shall occur once all equipment is in place and ready for operation. The Mechanical Contractor, the plumbing equipment systems' integrator, and the ATC Subcontractor shall meet on site to jointly program, schedule, verify points, interlock devices, and fully set up all systems integration components.

G. All systems integration coordination, programming, and graphics must be completed prior to requesting commissioning and/or inspections by the Engineer of Record.

1.22. LEAD FREE REQUIREMENTS

A. All plumbing fixtures, equipment, and devices that contact potable water must be lead free per the State requirements.

PART 2. ELECTRICAL REQUIREMENTS

2.01. GENERAL MOTOR AND ELECTRICAL REQUIREMENTS

A. Furnish and install control and interlock wiring for the equipment furnished. In general, power wiring and motor starting equipment will be provided under Division 26. Carefully review the contract documents to coordinate the electrical work under Division

22 with the work under Division 26. Where the electrical requirements of the equipment furnished differ from the provisions made under Division 26, make the necessary allowances under Division 22. Where no electrical provisions are made under Division 26, include all necessary electrical work under Division 22.

B. All electrical work performed under Division 22 shall conform to the applicable requirements of Division 26 and conforming to the National Electric Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA & International Building Code.

C. Provide wiring diagrams with electrical characteristics and connection requirements.

D. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than five (5) horsepower.

E. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.

F. All motors shall be furnished with visible nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor and efficiency.

G. Nominal efficiency and power factor shall be as scheduled at full load and rated voltage when tested in accordance with IEEE 112.

H. Brake horsepower load requirement at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.0 and 1.15 service factors.

I. All single phase motors shall be provided with thermal protection: Internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature ratings of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

2.02. MOTORS AND CONTROLS

A. Motors and controls shall conform to the latest requirements of IEEE, NEMA, NFPA-70 and shall be UL listed. Motor sizes are specified with the driven equipment. Motor starting and control equipment is specified either with the motor which is controlled or in an electrical specification section. The Contractor is advised to consult all specification sections to determine responsibility for motors and controls.

B. Motors shall be designed, built and tested in accordance with the latest revision of NEMA Standard MG l.

C. Motors shall be suitable for use under the conditions and with the equipment to which applied, and designed for operation on the electrical systems specified or indicated.

1. Motor capacities shall be such that the horsepower rating and the rated full-load

current will not be exceeded while operating under the specified operating conditions. Under no condition shall the motor current exceed that indicated on the nameplates.

2. Motor sizes noted in the individual equipment specifications are minimum requirements only. It is the responsibility of the equipment manufacturers and of the Contractor to furnish motors, electrical circuits and equipment of ample capacity to operate the equipment without overloading, exceeding the rated full-load current, or overheating at full-load capacity under the most severe operating service of this equipment. Motors shall have sufficient torque to accelerate the total WR^2 of the driven equipment to operating speed.

3. Motors shall be continuous duty type and shall operate quietly at all speeds and loads.

4. Motors shall be designed for operation on 60 hertz power service. Unless otherwise specified or shown, motors less than ½ horsepower shall be single phase, and motors ½ horsepower and larger shall be 3 phase unless otherwise noted.

5. Motors shall be mounted so that the motor can be removed without removing the entire driven unit.

D. Single phase motors, smaller than 1/20 horsepower shall be ball or sleeve bearing; drip-proof, totally enclosed or explosion proof, as specified; 120 volts; permanent-split capacitor or shaded pole type. These motors shall not be used for general power purposes, and shall only be provided as built-in components of plumbing equipment. When approved by the Engineer, deviations from the specifications will be permitted as follows:

1. Open motors may be installed as part of an assembly where enclosure within a cabinet provides protection against moisture.

2. Motors used in conjunction with low voltage control systems may have a voltage rating less than 115 volts.

E. Single phase motors, greater than 1/20 horsepower and less than ½ horsepower shall be ball bearing; drip-proof, totally enclosed or explosion proof, as specified, with Class A or B insulation, as standard with the motor manufacturer; 115 or 120/208/240 volts as required; capacitor start-induction run, permanent split capacitor, or repulsion start-induction run type with minimum efficiency of 70 percent and a minimum full load power of 77 percent.

F. Except as otherwise specified in the various specification sections, 3 phase motors 60 horsepower and smaller shall be NEMA design B squirrel cage induction type meeting the requirements of this paragraph. Motors shall be drip-proof, totally enclosed or explosion proof, as specified or indicated. Insulation shall be Class B or F, at 40 degrees C ambient temperature. Drip-proof motors shall have a 1.15 service factor and totally enclosed and explosion proof motors shall have a service factor of 1.00 or higher. Motors specified for operation at 480, 240, and 208 volts shall be nameplated 460, 230, 200 volts, respectively. Efficiencies and percent power factor at full load for three phase

motors shall be not less than the values listed below for premium efficiency motors:

MOTOR NAMEPLATE	MINIMUM PERCENT EFFICIENCY AT NOMINAL SPEED AND RATED LOAD	MINIMUM PERCENT POWER FACTOR
1HP and above to	85.5 percent	84 percent
1-½ HP	86.5 percent	85 percent
2HP	86.5 percent	85 percent
3HP	89.5 percent	86 percent
5HP	89.5 percent	87 percent
7½ HP	91 percent	86 percent
10HP	91.7 percent	85 percent
15HP	93.0 percent	85 percent
20HP	93.0 percent	86 percent
25HP	93.6 percent	85 percent
50HP	94.5 percent	88 percent
60 HP	95.0 percent	90 percent
75HP	95.0 percent	90 percent
100 HP	95.4 percent	90 percent
125 HP	95.8 percent	95 percent
150 HP and above	96.0 percent	95 percent

G. Three phase motors ½ HP or greater shall be the Duty Master XE by Reliance Electric Company, Super-E Premium Efficiency of Baldor Motor and Drives, E-plus Efficient Standard Duty Motor of the Electric Motor Division of Gould, Inc., the MAC II High Efficiency motor of Westinghouse Electric Corp., the equivalent product of General Electric, or approved equal.

H. For motors serving equipment being controlled by a variable speed drive, motor shall be premium efficiency inverter duty rated.

I. Motor frames shall be NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast-iron or aluminum with steel inserts.

J. Control of each motor shall be manual or automatic as specified for each in the various mechanical sections. In general, and unless otherwise specified for a particular item in the various mechanical sections of the specifications, motor starters and controls shall be specified and provided under the various electrical sections of these specifications.

2.03. MOTOR INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors to support shaft regardless of shaft position.

C. Check line voltage and phase and ensure agreement with nameplate. Check that proper thermal overloads have been installed prior to operating motors.

2.04. WIRING DIAGRAMS

A. The Contractor is responsible for obtaining and submitting wiring diagrams for all major items of equipment.

B. Wiring diagrams shall be provided with shop drawings for all equipment requiring electric power.

C. Provide wiring diagrams for all major plumbing items of equipment to electrical contractor and ATC subcontractor for coordination.

PART 3. EXECUTION

3.01. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to the Architect.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment giving right of way to piping installed at required slope.

3.02. SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For un-insulated copper piping provide copper hanger to prevent contact of dissimilar metals. All exterior hangers shall be constructed of stainless steel

utilizing stainless steel rods, nuts, washers, bolts, etc.

C. Concrete housekeeping pads and foundations shall be not less than 4 inches high and shall extend a minimum of 6 inches beyond equipment bases. Provide wire-mesh reinforcement; chamfer exposed edges and corners; and finish exposed surfaces smooth.

3.03. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a videographer to record demonstration and training video recordings. Record each training module separately.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Engineer

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.04. PROVISIONS FOR ACCESS

A. The contractor shall provide access panels and doors for all concealed equipment, valves, strainers, dampers, controls, control devices, cleanouts, traps, and other devices requiring maintenance, service, adjustment, balancing or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade

for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.05. PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 22 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed piping, equipment, etc. shall be painted. Colors shall be as stated in this division or as selected by the Architect and conform to ANSI Standards.

H. All exterior roof mounted equipment, piping and vents shall be painted to match roof in color as selected by Architect.

I. All exposed piping, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

J. All exposed piping, equipment, etc., in mechanical rooms, janitor’s closets, utility rooms, and storage where PVC jacketed shall not require painting. Label and identify and color code as specified.

1. Field-applied paints and coatings within the building interior: Comply with low-emitting requirements in Division 01 Section, “Indoor Air Quality Requirements”.

3.06. CLEANING OF SYSTEMS

A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers, and other accessory items. Blow out and flush piping until interior surfaces are free of foreign matter.

B. Flush piping in re-circulating water systems to remove cutting oil, excess pipe joint compound, solder slag and other foreign materials. Do not use system pumps until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling, the residual alkalinity shall not exceed 300 parts per million. Submit a certificate of completion to Engineer stating name of service company used.

C. Maintain strainers and dirt pockets in clean condition.

D. Pay for labor and materials required to locate and remove obstructions from systems that are clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.

E. Leave systems clean, and in complete running order.

3.07. COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

B. Submit color of factory-finished equipment for acceptance prior to ordering.

3.08. PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in piping and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.09. OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, balancing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing and balancing work. Testing and balancing work shall not

commence until start-up reports have been completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

D. Do not use plumbing systems for temporary services or temporary conditioning during construction. Refer to Division 01 section *"Temporary Facilities and Controls"* for temporary plumbing during construction.

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters.

3.10. IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS

A. Contractor shall submit for approval schematic piping diagrams of each piping system installed in the building. Diagrams shall indicate the location and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under safety glass and hung in each Mechanical Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.

B. All valves shall be plainly tagged. For any bypass valves, install sign indicating valve position as “Normally Open” or “Normally Closed” as required.

C. All items of equipment, including motor starters and disconnects shall be furnished with white on black plastic permanent identification cards. Lettering shall be a minimum of ¼ inch high. Identification plates shall be secured, affixed to each piece of equipment, starters, disconnects, panels by screw or adhesive (tuff bond #TB2 or as approved equal). Equipment identification and room name or area served shall be on each panel.

D. Provide six (6) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the *Operations and Maintenance Manuals* as hereinafter specified.

E. All lines piping installed under this contract shall be stenciled with *direction of flow* arrows and with stenciled letters naming each pipe and service. Refer to Division 22 Section, *Plumbing Piping, Fittings, Valves, Etc.* Color code all direction of flow arrows and labels. In finished spaces omit labeling and direction of flow arrows. Paint in color as selected by Architect.

F. Submit list of wording, symbols, letter size, and color coding for plumbing identification. Submit samples of equipment identification cards, piping labels, labels, and valve tags to Engineer for review prior to installation.

G. Provide at least eight (8) hours of straight time instruction to the operating personnel. Time of instruction shall be designated by the Owner. Additional instruction time for the automatic temperature control (ATC) system is specified in Division 23 Section, *Instrumentation and Controls of HVAC and Plumbing Systems*.

H. Contractor shall demonstrate Sequences of Operation of all plumbing equipment in presence of Owner’s representative, Commissioning Authority, and ATC subcontractor.

3.11. WALL AND FLOOR PENETRATION

A. All penetrations of partitions, ceilings, roofs and floors by piping or conduit under Division 22 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 07 Section, *HVAC and Plumbing Penetration Firestopping.*

B. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 07 Section, *HVAC and Plumbing Penetration Firestopping.*

C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.

D. Provide pipe escutcheons and duct flanges for sleeved pipes and ducts in finished areas.

E. Piping sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.

2. Twenty-two (22) gauge galvanized steel elsewhere.

3.12. RECORD DRAWINGS

A. Upon completion of the mechanical installations, the Contractor shall deliver to the Architect one complete set of prints of the mechanical contract drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.13. WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the *General Conditions and Supplementary Conditions.*

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer’s warranties shall be included in the operations and maintenance manuals.

C. The contractor guarantees for a two year period from the time of final acceptance by the Owner.

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.

2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.

3. That the contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.

4. That the entire work shall be water-tight and leak-proof.

3.14. LUBRICATION

A. All bearings, motors, and all equipment requiring lubrication shall be provided with accessible fittings for same. Before turning over the equipment to the Owner, the Contractor shall fully lubricate each item of equipment, shall provide one year's supply of lubricant for each, and shall provide Owner with complete written lubricating instructions, together with diagram locating the points requiring lubrication. Include this information in the *Operations and Maintenance Manuals*.

B. In general, all motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal accessible or extended grease fittings and drain plugs.

3.15. OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall have prepared six (6) copies of the *Operations and Maintenance Manuals* and deliver these copies of the manuals to the Owner. The manuals shall be as specified herein. The manuals must be approved and will not be accepted as final until so stamped.

B. The manuals shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manual Dover High School Outbuildings - Bid Pack G – Plumbing Systems.* No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the booklet:

1. As first entry, an approved letter indicating the starting/ending time of Contractor’s warranty period.
2. Catalog data on each piece of plumbing equipment furnished.
3. Maintenance operation and lubrication instructions on each piece of plumbing equipment furnished.
4. Complete catalog data on each piece of plumbing equipment furnished including approved shop drawing.
5. Manufacturer's extended limited warranties on equipment including but not limited to water heaters.
6. Chart form indicating frequency and type of routine maintenance for all plumbing equipment. The chart shall also indicate model number of equipment, location and service.

7. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
8. Provide supplier and subcontractor's names, address, and phone number.
9. Catalog data of all equipment, valves, etc. shall include wiring diagrams, parts list and assembly drawing.
10. Provide and install in locations as directed by the Owner, valve charts including valve tag number, valve type, valve model number, valve manufacturer, style, service and location. Each valve chart shall be enclosed in a durable polymer based frame with a cover safety glass. .
11. Copy of the approved balancing report for plumbing equipment/system.
12. Access panel charts with index illustrating the location and purpose of access panels.
13. Approved Health and Plumbing and Electrical Certificates.
14. Start-up reports for equipment.
15. Insert color graphic with embedded parameters for ATC system into Record and Information Booklet.

D. Submit *Operations and Maintenance Manuals* prior to the anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that *Operations and Maintenance Manuals* reviewed and approved.

3.16. INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following:

1. Complete Plumbing and HVAC Piping Drawings showing coordination with lights, electrical equipment, HVAC equipment and structural amenities.

B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, and piping in areas involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.

3.17. PIPING SYSTEMS TESTING

A. The entire new plumbing piping systems shall be tested hydrostatically before insulation covering is applied and proven tight under the following gauge pressures for a duration of four (4) hours. Testing to be witnessed by Owner's representative and documented in writing.

SYSTEM	TEST PRESSURE
Domestic Water Piping	100 psi

SYSTEM	TEST PRESSURE
Sanitary & Storm Water Piping	As specified below

B. All storm, waste, vent and water piping shall be tested by the Contractor and approved by the Engineer before acceptance. All storm, soil, and waste piping, located underground, shall be tested before backfilling. The costs of all equipment required for tests are to be included in the contract price.

C. The entire new drainage system and venting system shall have all necessary openings plugged and filled with water to the level of the highest stack above or at the roof. The system shall hold this water for thirty (30) minutes without showing a drop greater than 1inch. Where a portion of the system is to be tested, the test shall be conducted in the same manner as described for the entire system, except a vertical stack 10 feet above the highest horizontal line to be tested may be installed and filled with water to maintain sufficient pressure, or a pump may be used to supply the required pressure. The pressure shall be maintained for thirty (30) minutes. All testing shall be in accordance with the local Plumbing Code and witnessed by the Plumbing Inspector or authority having jurisdiction.

D. Upon completion of roughing-in and before setting equipment and fixtures, the entire new water piping system shall be tested at a hydrostatic pressure of not less than one hundred (100) pounds per square inch gauge and proven tight at this pressure. Where a portion of the water piping system is to be concealed before completion, this portion shall be tested separately in a manner described for the entire system.

E. Testing and acceptance thereof shall be in accordance with local requirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the *Operations and Maintenance Manuals*.

3.18. EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections. Failure to do so will not relieve this contractor of any responsibility for improper equipment operation.

END OF SECTION

DIVISION 22 SECTION 22 05 05
PLUMBING PIPING, FITTINGS AND VALVES
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SECTION 22 05 05

PLUMBING PIPING, FITTINGS AND VALVES

PART 1. GENERAL

1.01. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers, and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product data for Credit EQ 4.2: For paints and coatings applied within the building water proofing envelope, documentation including printed statement of VOC content in g/L.

3. Product Data for Credit MR 5.1 (and MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

1.02. SUMMARY

A. The conditions of the contract and other general requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 22 Section, Common Work Results for Plumbing and Division 01, *General Requirements*.

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

1.03. SYSTEM DESCRIPTION CONDITIONS

A. Provide all labor and materials necessary to furnish and install all piping systems on this project as herein specified and/or shown on the drawings. Final connections to equipment furnished in other sections of the specifications shall be included under this section.

B. All piping and insulation installed in ceiling plenums must be plenum rated and comply with NFPA and International Building Code (IBC).

C. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide

necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

D. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

E. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

F. Provide pipe hangers and supports in accordance with ASTM B31.9 and MSS SP69 unless indicated otherwise.

G. Use spring loaded "silent" check valves on discharge of all pumps.

H. Use 3/4 inch (20 mm) ball valves with threaded ends, cap, and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain. For the outbuildings that will be drained in the winter install Schrader valves, ball valves, and a drain values to allow complete drainage of all water containing piping.

I. At all runout piping serving equipment, use swing joints with elbows to prevent excessive movement of piping due to expansion.

1.04. QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. 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.

C. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.

D. Maintain one copy of each document on site.

1.05. DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site under as hereinbefore specified.

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.

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 systems.

1.06. ENVIRONMENTAL REQUIREMENTS

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

1.07. ALTERNATES

A. Refer to Division 01 - *Alternates* for description of work under this section affected by alternates.

1.08. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

1.09. LEAD FREE REQUIREMENTS

A. All plumbing fixtures, equipment, and devices that contact potable water must be lead free per the State requirements.

PART 2. PRODUCTS

2.01. PIPE MATERIALS

A. All materials, unless otherwise specified, shall be new and of the best quality of their respective kinds, and shall conform to the requirements and ordinances of local, state and insurance authorities having jurisdiction.

1. Sanitary Underground - Within Building to 5 Feet Outside of Foundation Wall:

   a). PVC Pipe: Schedule 40 DWV or cellular core. Fittings: Schedule 40 PVC, ASTM D 2665 or ASTM F891 socket fittings. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2. Sanitary and Vents Above Floor Inside Building:

   a). Pipe & Fittings: Cast iron *No-Hub* pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and listed by NSF International as compliant with CISPI 301, ASTM C564. Installation and support shall be in accordance with Cast Iron Soil Pipe Institute recommendation. Joints shall be made with neoprene gaskets and stainless steel clamp and shield assemblies listed by NSF International as compliant with CISPI 310. Sealing sleeve shall be polychloroprene (neoprene) based rubber sleeve conforming to ASTM C564.

   b). Hubless Cast Iron Soil Pipe and Fittings
      i. Hubless pipe and fittings must be listed by NSF International as compliant with CISPI 301.
      ii. Manufacturers:
         1) AB&I
         2) Charlotte

3) Tyler

c). Medium Duty Shielding Coupling, ASTM C 1540, Type 304 Stainless Steel corrugated shield and bands, and polychloroprene (neoprene) based rubber sleeve conforming to ASTM C564.
i. Approved manufacturers:
1) Clamp-All
2) Mission Rubber Company
3) Anaco

3. Indirect Waste Piping:

a). Pipe & Fittings: Hard drawn Type L copper tubing with cast brass drainage fittings. ASTM B88-78 and ANSI B16.1877. All exposed indirect waste piping shall be chrome plated or primed and painted with silver paint.

4. Storm Water Below Grade or Under Building to Point 5 Feet from Building Line:

a). PVC Pipe: Schedule 40 DWV or cellular core. Fittings: Schedule 40 PVC, ASTM D 2665 or ASTM F891 socket fittings. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

5. Storm Water Above Floor Inside Building:

a). Pipe & Fittings: Cast iron *no-hub*, pipe and fittings, CISPI 301. Installation and support shall be in accordance with Cast Iron Soil Pipe Institute recommendations. Joints shall be made with neoprene gaskets and stainless steel clamp and shield assemblies listed by NSF International as compliant with CISPI 310.

b). Hubless Cast Iron Soil Pipe and Fittings
i. Hubless pipe and fittings must be marked with the Cast Iron Soil Pipe Institute and listed by NSF International as compliant with CISPI 301.
ii. Manufacturers:
1) AB&I
2) Charlotte
3) Tyler

c). Medium Duty Shielding Coupling, ASTM C 1540, Type 304 Stainless Steel corrugated shield and bands, and polychloroprene (neoprene) based rubber sleeve conforming to ASTM C564.
i. Approved manufacturers:
1) Clamp-All
2) Mission Rubber Company
3) Anaco

6. Domestic Cold Water Outside of Building Below Ground or Under Building to Point 5 Feet from Building Line:

a). Pipe: 2-1/2 inches & smaller, soft temper type *K*. ASTM B88 - No joints below grade except as approved by the Engineer.

3 inches & larger, ductile iron pipe for water, ANSI 21.50 & 21.51 with double thickness cement mortar lining, ANSI 21.4.

b). Fittings & Joints: wrought copper solder joint fittings, ANSI B16.22. Joints for copper piping shall be ASTM B32, SOLDER, grade 95TA.

Cast iron pressure fittings, ANSI 21.10, Class 250. Mechanical specification for mechanical joint for cast iron pressure pipe & fittings ANSI A21.11. Joints for ductile iron pipe shall be AWWA C111, rubber gasket with 3/4 inch diameter rods.

7. Domestic Hot, Cold, and Recirc., Water Piping Inside Buildings, Above Grade:

a). Pipe or Tubing: 2 inches & smaller, all water lines soft temper Type *K* copper tubing below ground, hard temper Type *L* copper tubing above ground, ASTM B88, or Type 304/304L, Schedule 10S, stainless steel to ASTM A312.

2-1/2 inches & larger, hot dipped galvanized steel A120, ASTM A53, Grade B, Schedule 40 steel, or hard copper tube, Type L with copper-tube dimensioned grooved ends; copper ground - end fittings; copper tubing, keyed couplings; and grooved joints. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.)

Provide dielectric fittings between steel and copper. Victaulic Style 47 or approved equal.

b). Fittings & Joints: Copper tubing fittings and joints shall be solder type wrought copper - 95-5 silver solder or braze (lead and antimony based solders are prohibited). Galvanized steel pipe fittings and joints shall be ANSI B16.12 hot dipped galvanized threaded ends and 125 lb. galvanized cast iron fittings or 150 lb. galvanized malleable iron.

i. Stainless steel fittings shall be Vic-Press or approved equal for Schedule 10S pipe. Fittings shall be precision, cold drawn, stainless steel with EPDM O-ring seals. (Seals shall be UL classified in accordance with ANSI/NSF61 for Potable Water service.) Fittings rated for working pressures to 500-psi.

ii. Grooved joint couplings shall consist of two ductile iron housing segments cast with offsetting angle pattern bolt pads, FlushSeal elastomer gasket, and ASTM A449 electroplated steel bolts and nuts. (Gasket shall be UL classified in accordance with ASNI/NSF61 for Potable Water service.) Installation-Ready, for direct stab installation without field disassembly. Victaulic Style 607H or approved equal.

c). Gate Valves: 2-1/2 inches & larger - OS&Y, IBBM flanged, 125 lb. standard solid wedge.

2 inches & smaller - bronze solder end, bronze body, solid wedge, rising stem, 200 lb. w.o.g. non-shock. However, use brass valves only on all copper pipe.

d). Butterfly Valves: Cast bronze body to ASTM B584, elastomer coated ductile iron disc with integrally cast stem, with copper-tube dimensioned grooved ends, suitable for working pressures to 300-psig CWP Victaulic Style 608 or approved equal.

e). Ball Valves: Shut-off valves 2-inches and smaller shall be ball valves. Ball valves shall be 150 lbs, brass or bronze body, standard port, 2 piece body, TFE seats with bronze trim. Ball valves shall be threaded end or solder end, or Vic-Press end as required to accommodate piping. Ball valves shall be as manufactured by Victaulic, Conbraco, Crane, Apollo, Nibco, Watts or engineer approved equal.

f). Unions: 2-1/2 inches & larger - 150 lb. brass companion flanges.

2 inches & smaller - wrought copper, ground joint solder ends; threaded hexagonal stainless steel union with Vic-Press ends, Victaulic P589 or approved equal.

g). Check Valves: 2-1/2 inches & larger - IBBM, 125 lb. std. flanged bronze swing check, with metal disc; 2-inches and smaller - 125 lb. std. screwed or solder ends.

h). Globe Valves: 2 inches and smaller, bronze body, bronze trim, rising stem, hand wheel, inside screw, renewable composition disc, solder ends, 150 lb, with back seating capacity.

2 inches & larger: IBBM, 150 lb, bronze trim, rising stem, handwheel OS&Y, plug type disc, flanged ends, renewable seat and disc.

Globe valves shall be Conbraco, Crane, Nibco, Milwaukee, Watts or approved equal.

i). Combination Shut-off/Balancing Valves:

Victaulic/TA Hydronics, Taco Circuit Setter, Bell & Gossett Circuit Setter Plus, Flowset Accuset, Gerand, or engineer approved equal, ½ inch-3 inches 300 psi rated globe type or ball valve with Ametal (copper-alloy) or bronze body/brass ball construction with glass and carbon filled TFE seats, in-line flow meter and balancing and shut-off valve with built in ball valve for flow adjustment. Valve shall have memory stop, calibrated nameplate, Schrader valve connections and preformed molded insulation. Valves shall be leaktight at full rated working pressure. Balance valve size shall be selected based on manufacturer's acceptable flow range and design flow rate. Pressure drop through combination shut off balance valves shall not exceed 5 feet of head at design flow rate.

j). Extended Valve Stems: Provide and install round collar type extended valve stems on all valves installed in insulated piping. Valve stem and collar shall be selected to suit insulation thickness and maintain valve handles outside of insulation.

B. Steel pipe shall be similar and equal to National Tube Company, Grinnell, Republic, or Bethlehem black or zinc-coated (galvanized) as hereinafter specified. Pipe shall be free from all defects which may affect the durability for the intended use. Each length of pipe shall be stamped with the manufacturer's name.

C. Copper pipe shall be Revere, Anaconda or Chase with approved solder fittings.

2.02. PIPE HANGERS

A. All hangers for metallic piping shall be adjustable, wrought clevis type, or adjustable malleable split ring swivel type, having rods with machine threads. Hangers shall be Grinnell Company's Figure 260 for pipe ¾-inch and larger, and Figure 65 for pipe 2-inches and smaller, or approved equal. Adjustable pipe stanchion with U-bolt shall be Grinnell Company's Figure 191. Pipe roller supports shall be Grinnell's Figure 181 or Figure 271. Exterior pipe hangers shall be galvanized or stainless steel construction. For copper piping in direct contact with the hanger, hanger construction shall be copper coated to prevent contact of dissimilar metals similar to Grinnell's Figure CT-65. Hanger spacing and rod sizes for steel and copper pipe shall not be less than the following:

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
3/4 & 1	6	5	3/8
1 - ½	6	8	3/8
2	8	8	3/8
2 – ½	10	9	½
3	12	10	½
4	14	12	5/8
5	14	12	5/8
6	16	14	3/4
8	18	16	7/8
10	20	18	7/8
12	20	18	7/8

B. Install hangers for cast-iron and storm water soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. PS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
6. NPS 15 (DN 375): 60 inches (1500 mm) with 1-inch (25-mm) rod.
7. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

C. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

D. Anchors, guides, and roller supports shall be installed in accordance with the contract drawings and manufacturer's recommendations to provide pipe support and control pipe movement for all piping systems. Anchors and guides shall be securely attached to the pipe support structure. Submit shop drawing for proposed pipe support structure for guides and anchors for approval of the Structural Engineer. Pipe alignment guides shall be Fig. 255 Grinnell, or as approved equal. Guides shall be sized to accommodate the pipe with insulation. Guides shall be steel factory, fabricated, with bolted two section outer cylinder and base for alignment of piping and two section guiding spider for bolting to pipe.

E. Hangers for pipe sizes ½ to 1 ½ inch (13 to 38 mm): Carbon steel, adjustable swivel, split ring.

F. Hangers for cold pipe sizes 2 inches (50 mm) and over: Carbon steel, adjustable, clevis.

G. Hangers for cold pipe sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.

H. Multiple or Trapeze hangers: Steel channels with welded spacers and hanger rods.

I. Wall support for pipe sizes to 3 inches (76 mm): cast iron hook

J. Wall support for pipe sizes 4 inches (100 mm) and over: Welded steel bracket and wrought steel clamp.

K. Vertical Support: Steel riser clamp.

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

M. Copper pipe support: Carbon steel ring, adjustable, copper plated.

N. Hanger rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

O. 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.

2.03. VALVES

A. Provide parts list and assembly drawings (exploded view) for all valves in shop drawing submittals. Provide valves of the same type by the same manufacturer.

B. Check valves in circulator discharges shall be horizontal type.

C. Multi-purpose valve (non-slam check valve, throttling valve, shut-off valves and calibrated balancing valve) shall be provided at discharge side of each constant speed pump. The valve shall be of heavy-duty cast iron construction with standard ANSI flanged connections and rated for a maximum working pressure of 175 psig at 240^{o}F. The valve shall be fitted with a stainless steel stem or stem sleeve and brass seat with "O" ring seal. Valve shall be Taco "Plus One" Number 300-4.2, Bell and Gossett 3DS Triple Duty Valve, Armstrong, or as approved equal, and shall have check and plug valve features plus a memory stop with pointer and scale. Provide additional shut-off valve to allow servicing of check valve if a multipurpose valve is utilized in lieu of separate check, shut-off, and balance valve. Provide additional shut-off valve downstream of multi-purpose valve to allow servicing of multi-purpose check valve feature. Provide pre-manufactured, removable insulation covers for all multipurpose valves.

2.04. STRAINERS

A. Strainers shall be of the basket or "Y" type and shall be heavy and durable, constructed of best grade gray iron with the bottoms drilled and plugged. Bodies shall have arrows clearly cast on the sides to show flow direction. Strainers shall be equipped with easily removable covers and brass sediment baskets made of brass not less than #22 gauge in thickness. Total area of basket perforations shall be not less than four times the cross section of the entering pipe. Flow shall be into basket, and then out through the perforations. Strainers shall be suitable for water or the intended fluid. Strainers 2 inches and smaller shall have threaded or solder ends, 2 inches and larger shall have flanged ends.

B. Strainer screens shall be stainless steel with perforations and shall be 1/16-inch for pipe sizes 5 inches and less, 1/8-inch (40 percent open area) perforations for pipe sizes 6-inch and greater.

C. Provide valved and capped (with chain) blowdowns in each strainer. Blowdown valves shall be Appolo 78-100/200 series or as approved equal.

D. Strainers shall be manufactured by Watts, Mueller, Armstrong, Yarway, Spirax/Sarco or as approved equal.

2.05. UNIONS, FLANGES, AND COUPLINGS

A. Unions in steel pipe 2-inches and smaller shall be malleable iron with brass inserted seats designed for a working pressure of 150 psig.

B. Unions in copper pipe 2-inches and smaller shall be sweat fittings with bronze seats designed for a working pressure of 125 psig.

C. Flanges for steel pipe over 2 inches shall be 150 psig, forged steel, slip on. Gaskets shall be 1/16 inch thick pre-formed neoprene.

D. Flanges for copper pipe over 2 inches shall be bronze. Gaskets shall be 1/16 inch thick preformed neoprene.

2.06. MANUAL AIR VENTS

A. Manual air vents shall be similar to the hereinafter specified gauge valves. Provide 1/4-inch size on ¾-inch pipe and smaller, ½ -inch size on 1-inch pipe and larger. Install at all high points of piping. Valves shall be Crane No. 88, or as approved equal, with threaded ends, bronze body, bronze or brass bonnet and bronze stem.

2.07. THERMOMETERS

A. Unless otherwise indicated, thermometers shall be ASTM E1, in a glass type, organic filled, 9-inch scale size, corrosion-resistant metal case, with "any-angle" mounting with positive locking device. Trerice Industrial Thermometers, Weksler Instruments, Ernst Gage Co., Miljoco, or approved equal. Insertion stem length shall suite the pipe size and configuration. Thermometer wells shall be brass with brass union hubs in copper and in ferrous piping. Where piping is insulated or otherwise covered, use wells with lagging extension. Where wells are installed in pipe tees at turns, increase pipe size so that well does not restrict flow. Accuracy shall be 2 percent.

B. Unless otherwise indicated, thermometer ranges shall be as follows:

1. Domestic cold water: 0 degrees F to 100 degrees F, 1 degrees F Division.
2. Domestic hot and recirc. water: 30 degrees F to 240 degrees F, 2 degrees F Division.

C. Provide heat conducting compound in wells.

D. At Contractor's option, light powered thermometers may be utilized in lieu of organic filled thermometers.

2.08. PRESSURE GAUGES

A. Unless otherwise indicated, pressure gauges shall be the bronze bourdon tube type, 4-1/2-inch dial, stem mounting, cast aluminum adjustable pointer, 1 percent accuracy over middle half of scale range, 1-1/2 percent over balance: Trerice Model 600C; Weksler Instruments, Ernst Gage Co., Miljoco, or as approved equal.

B. Gauges shall have pressure, vacuum, compound, or retard ranges as required, select ranges so that the normal readings are at the approximate midpoint and maximum system pressures do not exceed full scale.

C. Furnish and install a gauge valve at each pressure gauge. Gauge valves shall be Crane

Model No. 88, Needle Valve, Ernst Gage Co. FLG 200, Wexler Instrument Corp. Type BBV4, or approved equal, rated for pressure intended.

D. Gauge connections for pressure gauges, thermometers, or control instruments shall be made using tee fittings, except that gauge connections up to 1-inch size in steel may be using threaded extra heavy pipe couplings welded directly to the main, provided that the main is at least 2-inch size for 2-inch connections, 3-inch size for 3/4-inch connections, and 4-inch size for 1-inch connections. Minimum gauge connection shall be 2-inch ips.

E. Provide snubbers on all gauges. Snubbers shall be No. 872 by Trerice, RS1/RS6 by Wexler Instruments, Miljoco or as approved equal.

2.09. PIPING SPECIALTIES

A. Pressure relief valves shall be provided in the number and sizes required to relieve 110 percent of the full input to the systems. Valves shall be rated; and installed in accordance with ASME, and CSD-1 including all amendments. Pipe discharge full size to floor drain, (with union) and support discharge pipe to prevent exerting any strain on relief valve body, piping to be Type-L copper. Water safety relief valves shall be Watts Series 740, Conbraco, Series 154A, Bell and Gossett, or approved equal. Provide pressure gauge adjacent to all safety relief valves.

2.10. ESCUTCHEONS

A. Provide chromium plated escutcheons properly fitted and secured with set screws on all exposed piping which passes through walls, floors or ceilings of finished spaces.

B. All escutcheon plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface. Plastic escutcheon plates will not be accepted.

2.11. DIELECTRIC CONNECTIONS:

A. Furnish and install electrically insulated dielectric unions, waterway fittings, or flanges, as manufactured by Victaulic Company, EPCO Sales, Inc., at the following locations:

1. Where steel piping systems join copper piping.

2. Where copper tube connects to water heaters, expansion tanks, and other steel vessels.

3. Avoid the installation of steel nipples, cast iron or steel valves and specialties, or other ferrous components in predominately copper piping systems. Where such installation is necessary, isolate the component with dielectric connections. Do not mix steel pipe and copper tube in the same run of pipe or in the same section of a piping system.

2.12. SLEEVES

A. Sleeves shall be provided around all pipes through walls, floors, ceilings, partitions, roof structure members or other building parts. Sleeves shall be standard weight galvanized iron

pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing through frame walls.

B. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves. Each trade shall be responsible for drilling existing floors and walls for necessary sleeve holes. Drilling methods and tools shall be as hereinbefore specified.

C. Sleeves through walls and floors shall be sealed with a waterproof caulking compound.

D. Firestop at sleeves that penetrate smoke barriers smoke partitions and/or rated walls/floors.

2.13. WATER PROOF PIPE PENETRATION SEALS

A. Provide and install waterproof pipe penetration seals at all pipes that enter the building below grade or through exterior wall.

B. Link seals are to be Metraflex Metraseals, Model MS, Linkseal, or approved equal, black EPDM seal material, glass reinforced plastic pressure plates, zinc plated nuts and bolts, seals are to be resistant to sunlight and ozone, pressure rated to make a hydrostatic seal of up to 20 psig and up to 40 feet of head, temperature rated from –40 degrees F to 250 degrees F.

2.14. TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.

2. Pressure rating at least equal to pipes to be joined.

3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Plastic-to-Metal Transition Fittings:

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

a). Charlotte Pipe and Foundry Company.
b). Harvel Plastics, Inc.
c). Spears Manufacturing Company.

2. Description: PVC or CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket end.

D. Plastic-to-Metal Transition Unions:

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

   a). Colonial Engineering, Inc.
   b). NIBCO INC.
   c). Spears Manufacturing Company.

2. Description: PVC or CPVC four-part union. Include brass threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.

2.15. SCHRADER VALVE

A. ¼ inch Schrader valve suitable for introducing compressed air for freeze protection of piping. Valve shall be brass or stainless steel and shall be furnished with threaded cap.

B. Install ball valve for positive shut-off as detailed.

C. Install ¾" drain valves with treaded ends to allow complete drainage of water containing pipes.

PART 3. EXECUTION

3.01. GENERAL PIPING INSTALLATION REQUIREMENTS

A. All pipes shall be cut accurately to measurements established at the building, and shall be worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. All pipes shall be so installed as to permit free expansion and contraction without causing damage. All open ends of pipe lines, equipment, etc., shall be properly capped or plugged during installation to keep dirt or other foreign material out of the system. All pipes shall be run parallel with the lines of the building and as close to walls, columns and ceilings as may be practical, with proper pitch. All piping shall be arranged so as not to interfere with removal of other equipment on devices not to block access to doors, windows, manholes, or other access openings. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment, coils, etc., and installed so that there will be no interference with the installation of the equipment, ducts, etc. All valves and specialties shall be placed to permit easy operation and access and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. All piping shall be installed so as to avoid air or liquid pockets throughout the work. Ends of pipe shall be reamed so as to remove all burrs.

B. All piping shall be graded to convey entrained air to high points where automatic air vents shall be provided. The size of supply and return pipes for each piece of equipment shall in no case be smaller than the outlets in the equipment.

C. All piping shall be run to provide a minimum clearance of 2-inches between finished covering on such piping and all adjacent work. Group piping wherever practical at common elevations.

D. All valves, strainers, caps, and other fittings shall be readily accessible.

E. Rough-in and final connections are required to all equipment and fixtures provided under this Contract.

F. Drain valves with hose connections shall be provided at low points for drainage of piping systems. Blow down valves shall be provided at the ends of all mains and branches so as to properly clean by blowing down the lines throughout in the direction of normal flow.

G. Discharge lines from all relief valves shall be piped to within 4-inches of floor and extend to floor drains wherever floors are not pitched to drains. Pitch the relief valve piping away from the relief valve to issue that no fluid can be trapped in valve discharge. Support all relief valve piping to prevent exerting strain on the relief valve body. The end of the relief valve discharge piping shall not be threaded to prevent capping or plugging.

H. All branches from water mains shall be taken from the top of the supply mains at an angle of forty-five (45) degrees above the horizontal, unless otherwise directed. Branches feeding down shall be taken from the side or bottom of the main on water mains only. All connections shall be carefully made to insure unrestricted circulation, eliminate air pockets or trapped condensate, and permit the complete drainage of the system.

I. Cutoff valves shall be provided on each branch line from the mains on all plumbing lines.

J. Shut-off valves shall be installed at the inlet and outlet of each piece of equipment to permit isolation for maintenance and repair.

K. Balancing valves shall be installed in all domestic re-circulating systems and at all pumps, and where indicated on the drawings.

L. Unions shall be installed on all bypasses, at all connections to equipment, where shown on drawings or where required to facilitate removal of equipment whether shown or not.

M. Spring clamp plates (escutcheons) shall be provided where pipes are exposed in the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface.

N. If the size of any piping is not clearly evident in the drawings, the Contractor shall request instructions for the Engineer as to the proper sizing. Any changes resulting from the Contractor's failure to request clarification shall be at his expense. Where pipe size discrepancies or conflicts exist in the drawings, the larger pipe size shall govern.

O. Install all valves with stem upright or horizontal, not inverted.

P. Where pipe support members are welded to structural building framing, scrape, brush clean, weld and apply one coat of zinc rich primer.

Q. Provide clearance for installation of insulation and access to valves and fittings.

R. Protect piping systems from entry of foreign materials by temporary covers, completing

sections of the work, and isolating parts of completed system.

S. All water containing pipes shall be routed clear of louvers to prevent freezing condition when dampers are open.

T. Provide manual air vents at top of piping systems.

U. Install Schrader valves, ball valves, and drain valve so that all piping can be drained down in winter months. Fill domestic water systems and demonstrate drain down procedure to Owner's Maintenance staff.

3.02. THERMOMETER AND PRESSURE GAGE INSTALLATION REQUIREMENTS.

A. Install thermometers and adjust vertical and tilted positions.

B. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

1. Install with socket extending to one-third diameter of pipe.

2. Fill sockets with oil or graphite and secure caps.

C. Install pressure gages in piping tees with pressure-gage valve located on a pipe at most readable location.

D. Adjust faces of thermometer and gages to proper angle for best visibility.

E. Clean windows of thermometer and gauges and clean factory-finished surfaces. Replace cracked and broken window, and repair scratched and marred surfaces with manufacturer's touch up paint.

3.03. VALVE INSTALLATION REQUIREMENTS

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

G. Install valves as indicated, according to manufacturer's written instructions.

H. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

I. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

J. Locate valves for easy access and provide separate support where necessary.

K. Install valves in horizontal piping with stem at or above the center of the pipe.

L. Install valves in a position to allow full stem movement.

3.04. WASTE AND VENT PIPING INSTALLATION REQUIREMENTS

A. Each pipe shall be laid true to line and grade and in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line. All pipe when laid shall rest on the full length of the barrel and bell holes shall be dug in trench bottoms to make joints. Pipe shall not be adjusted to grade by use of block or wedges. Where rock or old foundations are encountered, trenches shall be excavated 6-inches below grade and crusher run limestone shall be used as a bedding material to support barrel of pipe.

B. As the work progresses, the interior of the sewer shall be cleared of all dirt and superfluous materials of every description.

C. Trenches shall be kept free from water until the pipe jointing material has set and pipe shall not be laid when the conditions of the trench or the weather is unsuitable for such work. At all times, when work is not in progress, all open ends of pipe and fittings shall be securely closed to the satisfaction of the Engineer, so that no trench water, earth or other substance will enter the pipe or fittings.

D. Slip joints will be permitted only in trap seals or on the inlet side of the trap. Unions on the sewer side of the trap shall be ground faced, and shall not be concealed or enclosed. Install bell and spigot pipe with bell end upstream.

E. Threaded joints shall be American Standard taper screw threads with permacel joint compound applied to the male thread. Connections between threaded pipe and cast iron pipe shall have a ring or half coupling screwed on to form a spigot end on the threaded pipe.

F. Establish invert elevations, slopes for drainage to 1/8 inch per foot. Maintain gradients.

3.05. PIPE JOINTS INSTALLATION REQUIREMENTS

A. Grooved Joints: Grooved joint shall be installed in accordance with the manufacturer’s written recommendations. Grooved ends shall be clean and free from indentations, projections, or roll marks. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service. The coupling manufacturer’s

factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. (A distributor's representative is not considered qualified to conduct the training.)

B. Soldered Joints and Copper Piping: Joints in copper piping shall conform to the following minimum standards.

1. The pipes shall be cut to a length making certain that the ends are square, using a fins hacksaw blade or tube cutter. The ends of all pipes shall be reamed and all burrs removed.

2. The outside end of the pipe and the cut end of the fitting shall be cleaned with steel wool, sand cloth, or steel wire brush. All dark spots shall be removed.

3. The flux shall be applied evenly and sparingly to the outside end of the pipe and the inside of the outer end of the fitting until all surfaces to be jointed are completely covered. The piping and fitting shall be slipped together and reworked several times to insure an even distribution of the flux.

4. The correct amount of solder per joint for each size pipe shall be used in accordance with the manufacturer's recommendations.

5. Solder joints shall be made by using a direct flame from a torch.

6. On pipe sizes larger than ¼-inch, the fittings and valves in the pipe shall be moved or tapped with a hammer when the solder starts to melt to insure an even distribution of the solder.

7. The excess solder shall be removed while it is still in the plastic state leaving a fillet around the cup of the fitting.

8. Solder joints shall be suitable for working pressure of 100 psig and for working temperature of not less than 250 degrees F. The type of solder and flux used will be submitted for approval. Type 95-5 shall be the minimum standard.

9. Lead and antimony-based solders shall not be used for potable water systems. Brazing and silver solders are acceptable.

C. Where copper piping joins steel piping, approved bronze adapters shall be used.

D. Prohibited Connections: No direct weld, soldered, or brazed connections, without unions or flanges, shall be made to valves, strainers, apparatus, or related equipment. Right and left couplings, long threads, or caulking of pipe threads or gasket joints will not be permitted.

E. Mechanical specification for mechanical joint for cast iron pressure pipe & fittings, ANSI A21.11.

F. Plastic piping solvent cement joints: Clean and dry joining surfaces. Join pipe and fittings

according to the following:

1. Comply with ASTM F 402 for safe handling practice of cleaners, primers, and solvent cements. Apply primer.
2. PVC Piping: Join according to ASTM D2855.
3. CPVC Piping: Join according to ASTM D284.6/D 2845M Appendix.

3.06. HANGERS AND SUPPORTS INSTALLATION REQUIREMENTS

A. General: All hangers shall be of an approved type arranged to maintain the required grading and pitching of lines to prevent vibration and to provide for expansion and contraction. Provide protection saddles between hangers and insulation on heating water insulated pipe. Saddles shall be Grinnells Figure 173/273 or approved equal. Provide approved spacers between saddles and pipe where flexible insulation is specified. Provide insulation protection shields for insulated piping without saddles. Shield shall be Grinnell Figure 167 or as approved equal.

B. Spacing: Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping. For cast iron soil pipe, one hanger shall be placed at each hub or bell.

C. Vertical Lines: Shall be supported at their bases, using either a suitable hanger placed in a horizontal line near the riser, or a base type fitting set on a pedestal, foundation or support. All vertical lines extending through more than one floor level shall be supported at each floor with a riser clamp. Riser clamp shall be Grinnell Co.'s Figure 261, or approved equal. All vertical drops to pump suction elbows shall be supported by floor posts.

D. Racks and Brackets: All horizontal piping on vertical walls shall be properly supported by suitable racks securely anchored into the wall construction. Where not practical to obtain ceiling anchorage, all piping near walls shall be supported by approved brackets securely anchored into the wall construction. Washer plates (Fib. 60, 60L) and other miscellaneous attachments, fasteners, etc., shall be Grinnell or as approved equal. All exterior hanger and bracket systems in their entirety shall be galvanized.

E. Pipe Hangers and supports shall be attached to the panel point at the top chord of bar joist or at a location approved by the structural engineer.

F. Select hangers and components for loads imposed. Secure rods with double nuts.

G. Support of horizontal piping shall allow for vertical adjustment after installation of piping.

H. Support overhead piping with clevis hangers.

I. Do not support all parallel piping from the same joist. Stagger all supports in accordance with the structural engineer's recommendations.

J. Refer to structural documents for appropriate connection/attachment materials to building.

3.07. AIR VENTING INSTALLATION

A. The top of each plumbing piping system and other points as indicated or where necessary for the removal of air from the system or equipment, shall be vented using an approved type of manual air vent.

B. In addition to manual air vents at high points of system, each item of water heat transfer equipment shall be manually vented using an approved type manual air vent. All air vents shall be accessible.

3.08. SWING CONNECTION INSTALLATION REQUIREMENTS

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

B. Connect risers and branch connections to plumbing equipment with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to plumbing equipment with at least four pipe fittings, including tee in main.

3.09. PIPING IDENTIFICATION INSTALLATION

A. All piping shall be identified with painted background marked with the name of the service with arrows to indicate flow direction. Color code and system identification shall comply with ANSI Standards and piping identification system shall comply with ASME A13.1-81., scheme for the identification of piping systems and ASHRAE Fundamentals Handbook, latest edition.

B. Markings shall be plain block letters, stenciled on pipes, and shall be located near each branch connection, near each valve, and at least every 10 feet on straight runs of pipe. Where pipes are adjacent to each other, markings shall be neatly lined up. All markings shall be located in such manner as to be easily legible from the floor. Pipe identification schedule shall be as follows:

OUTSIDE DIAMETER OF PIPE OR COVERING (INCHES)	LENGTH OF COLOR FIELD (INCHES)	SIZE OF LETTERS (INCHES)
½ to 1 ¼	8	½
1-½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
Over 10	32	3 ½

3.10. VALVE IDENTIFICATION

A. All valves shall be tagged with a numbered tag.

B. The tags shall be made of 1-inch diameter brass tags fastened to the valve by means of brass

chains. Numbers shall agree with valve numbers on diagrammatic herein before specified.

C. Provide a minimum of six (6) valve charts with valve numbers indicating valve type, size, manufacturer and service.

D. Additional valve charts shall be mounted behind glazed wooden frames and be hung in each mechanical equipment room including each air handling unit mechanical equipment room. Additional copies shall be provided in each copy of the O&M manuals.

3.11. CLEANING PIPING AND EQUIPMENT

A. All water and plumbing piping systems shall be cleaned by filling with a solution of one (1) pound of trisodium phosphate to each 50 gallons of water and circulating this solution for a period of six (6) hours during which time the system shall reach operating temperature. The systems shall then be flushed with fresh water and refilled with fresh water purged of all air.

B. All water and plumbing piping system shall be flushed clean with fresh water. See Division 22 Sections, *Plumbing Fixture* and *Plumbing Equipment* for domestic potable water cleaning and sterilization.

END OF SECTION

DIVISION 22 SECTION 22 07 01
PLUMBING INSULATION

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SECTION 22 07 01

PLUMBING INSULATION

PART 1. GENERAL

1.01. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers, and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

3. Product data for Credit EQ 4.1: For adhesives, welding solvents and sealants applied within the building water proofing envelope, documentation including printed statement of VOC content in g/L.

1.02. REFERENCE

A. The Conditions of the Contract and other General Requirements apply to the work specified in this Section. All work under this Section shall be subject to the requirements of Division 22 Section, *Common Work Results for Plumbing*.

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

1.03. DESCRIPTION

A. All piping and equipment installed under this Contract shall be covered as specified.

1.04. SCOPE

A. The work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to all piping, equipment, and systems, in accordance with applicable project specifications and drawings, subject to the terms and conditions of the contract.

1.05. STANDARDS

A. Thermal insulation materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or use:

1. American Society for Testing of Materials Specifications:

a). ASTM C 547, “Standard Specification for Mineral Fiber Preformed Pipe Insulation”.

b). ASTM C 533, “Standard Specification for Calcium Silicate Pipe & Block Insulation”.

c). ASTM C 55, “Standard Specification for Mineral Fiber Blanket and Felt Insulation”.

d). ASTM C 585, “Recommended Practice for Inner and Outer Diameters of Rigid Pipe Insulation for Nominal Sizes of Pipe and Tubing (NPS System)”.

e). ASTM C 612, “Standard Specification for Mineral Fiber Block and Board Thermal Insulation”.

f). ASTM C 1136, “Standard Specification for Barrier Material, Vapor, “Type 1 or 2 (Jacket only).

g). ASHRAE 90.1 “Energy efficient design of new buildings except low-rise residential buildings”, latest edition.

B. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

1.06. SYSTEM PERFORMANCE

A. Insulation materials furnished and installed hereunder should meet the minimum economic insulation thickness requirements of the North American Insulation Manufacturers’ Association (NAIMA) (formerly known as TIMA), to ensure cost-effective energy conservation performance. Alternatively, materials should meet the minimum thickness requirements of National Voluntary Consensus Standard 90.1, (latest edition) and “Energy Efficient Design of New Buildings,” of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), latest edition. However, if other factors such as condensation control or personnel protection are to be considered, the selection of the thickness of insulation should satisfy the controlling factor. As minimum, all insulation thicknesses shall be as hereinafter specified.

B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of any one of the following specifications:

1.	American Society for Testing of Materials	ASTM E 84
2.	Underwriters' Laboratories, Inc.	UL 723
3.	National Fire Protection Association	NFPA 255

C. Calcium silicate products shall include a visual identification system to permit positive field determination of their asbestos-free characteristics.

1.07. QUALITY ASSURANCE

A. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications listed in Section 1.4 above.

B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

1.08. DELIVERY AND STORAGE OF MATERIALS

A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

B. The Contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The Contractor shall also use all means necessary to protect work and materials installed by other trades.

C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the Contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the Contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer in writing for technical assistance.

D. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements. Protect all insulation from water, construction traffic, dirt, chemical and mechanical damage.

1.09. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

1.010. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

PART 2. PRODUCTS

2.01. GENERAL

A. All materials to be insulated shall be thoroughly cleaned, after completion of successful tests, and shall be covered as specified below. Fiberglass insulation shall be Owens-Corning, Manville, Armstrong, or P.P.G, or as approved equal.

2.02. PIPE INSULATION MATERIALS

A. Unless otherwise noted, insulation shall be one piece or half sectional molded fibrous glass with "K" rating of .23 at 75 degrees F mean temperature, for service temperatures between -60 degrees F and +450 degrees F with all service jacket. Pipe insulation shall be fiberglass SSL II with double closure system as manufactured by Owens Corning, Johns Manville, Knauf or approved equal.

B. Unless otherwise noted, pipe insulation jacket shall be factory-applied vinyl coated, embossed and reinforced vapor barrier laminate, with a perm rating of not more than 0.02 perms. All hot and cold, concealed and exposed butt strips shall be of the same material as the jacket. Jacket and butt strips shall be sealed with field-applied Benjamin Foster adhesive. Jacket and butt strips shall be off-white color and shall be equivalent to Owens-Corning Fiberglass 25-ASJ.

C. For fittings on all piping, valves and flanges, apply fiberglass molded or segmented insulation equal in thickness to the adjoining insulation and securely fasten in place using wire. Apply a skin coat of insulating cement to produce a smooth surface. After cement is dry, apply a light coat of fitting mastic, UL labeled, Type C, for cold water piping, and Type H for hot water piping. Wrap fitting with fiberglass reinforcing cloth overlapping adjoining sections of pipe insulation by 2-inches. Apply a second coat of Type C or Type H mastic over the reinforcing cloth, working it to a smooth finish. As an option to the above fittings, a polyvinyl chloride fitting cover may be supplied.

D. All pipe insulation, jackets, or facings, and adhesives used to adhere jacket or facing to the insulation, including fittings and butt strips, shall have non-combustible fire and smoke hazard system rating and label as tested by ASTM E-84, NFPA 225, and UL 73, not exceeding Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Accessories such as adhesives, mastic cements, tapes and cloth for fittings shall have the same ratings as listed above. All products or their shipping cartons shall bear the Underwriter's label indicating that flame and smoke ratings do not exceed the above criteria.

E. On cold systems such as domestic cold water, rainleaders, vapor barrier performance is extremely important. All penetrations of the ASJ and exposed ends of insulation must be sealed with vapor barrier mastic. The ASJ must be protected with either a mastic coating or a suitable vapor retarding outer jacket. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

F. Fittings and valves shall be insulated with pre-formed fiberglass fittings, fabricated sections of Fiberglass pipe insulation, Fiberglass pipe and tank insulation, Fiberglass blanket insulation, or insulating cement. Thickness shall be equal to adjacent pipe insulation. Finish

shall be with pre-formed PVC fitting covers or as otherwise specified on contract drawings. Where applicable, Victaulic PVC fitting valve and coupling covers shall be utilized. Victaulic PVC covers shall be installed with matching pipe insulation jacketing material, vinyl tape, solvent weld adhesive and appropriate fasteners.

1. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough cut ends shall be coated with a suitable weather or vapor-resistant mastic as dictated by the system location and service. Finish valve installation with a Tyvac jacket with ends that secure to adjacent piping.

2. On hot systems where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.

3. On cold systems, particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier. All valve stems must be sealed with caulking which allows free movement of the stem but provides a seal against moisture incursion. All gauge and thermometer penetrations and extensions shall be correctly sealed and insulated to prevent surface condensation.

G. All piping shall be supported in such a manner that neither the insulation or the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing must be such that the circumferential joint may be made outside the hanger. On cold systems, vapor barrier must be continuous, including material covered by the hanger saddle.

1. Piping systems 3-inches (7.5cm) in diameter or less, insulated with Fiberglass insulation, may be supported by placing saddles of the proper length and spacing, as designated in Owens-Corning Pub. 1-IN-12534, under the insulation. Hangers saddles shall be minimum 16 gauge with a saddle arc of 120 degrees minimum.

2. For hot or cold piping systems larger than 3-inches (7.5 cm) in diameter, operating at temperatures less than +200 degrees F (93 degrees C) and insulated with fiber glass, high density inserts such as foam with sufficient compressive strength shall be used to support the weight of the piping system. At temperatures exceeding $\pm$200 degrees F (93 degrees C), Owens-Corning Pink Calcium Silicate pipe insulation shall be used for high density inserts.

3. Owens-Corning Pink Calcium Silicate pipe insulation may be used to support the entire weight of the piping system provided the hanger saddle is designed so the maximum compressive load does not exceed 100 psi (7kg/cm).

4. Where pipe shoes and roller supports are required, insulation shall be inserted in the pipe shoe to minimize pipe heat loss. Where possible, the pipe shoe shall be sized to be flush with the outer pipe insulation diameter.

5. Thermal expansion and contraction of the piping and insulation system shall generally be taken care of by utilizing double layers of insulation and staggering both longitudinal and circumferential joints. Where long runs are encountered, expansion joints may be required where single layers of insulation are being used and should be so noted on the contract drawings.

6. On vertical runs, insulation support rings shall be used.

2.03. PIPING INSULATION THICKNESSES SCHEDULE

A. All piping shall be insulated with pipe insulation of the thicknesses indicted below:

PIPING INSULATION THICKNESS SCHEDULE SERVICES	THICKNESS
All Horizontal Roof Drain Piping Including Sumps	1-inch thickness
All Domestic Hot and Cold Water Piping, including Re-circulating Piping	1-inch thickness
Above Grade Trap Priming Lines	½ -inch thickness
Electric Water Cooler Drains	1-inch thickness

2.04. EQUIPMENT INSULATION MATERIALS AND THICKNESSES

A. The following equipment shall be insulated with Fiberglass Rigid Board Insulation or Foam Plastic Insulation:

1. Expansion Tanks.

2. Domestic Water Meters.

3. Backflow Preventer Valve Bodies.

4. Plumbing Pumps.

5. All Pump Volutes and Strainers.

B. Insulation for cold surfaces shall be 1-1/2-inch thickness, 6 lb. density, 705 FRK with a "K" rating of .23 at 75 degrees F mean temperature. Insulation for hot surfaces except as otherwise noted shall be 1-1/2-inch thickness, 6 lb. density, 705 with a "K" rating of .23 at 75 degrees F mean temperature. Insulation shall be applied with staggered joints firmly butted and joined. The insulation shall be held in place by steel bands. Bands shall be 1-inch by 25 gauge galvanized steel spaced on not over 12-inch centers. All joints and voids shall be filled with Owens-Corning #110 cement, well troweled into openings. For 705 FRK insulation, all joints and voids shall be FRK taped and vapor sealed. There shall be applied over the insulation surface 1-inch galvanized wire netting laced together at all edges and wired to the steel bands with 16 gauge soft annealed wire. Over this shall be applied 2-inch thick layer of Owens-Corning #110 cement applied in two layers. Install metal corner beads

at all corners and edges in order to provide a permanent installation. Onto the dry cement surface apply a brush coat of Foster Sealfas 30-36 at the rate of 60-70 square feet per gallon. Embed into wet coating a layer of 8 ounce canvas smoothed out to avoid wrinkles and lap all seams a minimum of 2-inches. Apply a second brush coat of Sealfas 30-36 to the entire surface at the rate of 60-70 square feet per gallon. Cleanouts, nameplates, and manholes shall not be insulated, and the insulation on surrounding surfaces shall be neatly beveled off at such openings.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from aluminum at least 0.040 inch (1.0 mm) thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

D. Mechanical fasteners shall be utilized to hold insulation to surface with bands as required to hold the curvature of the material.

E. Support rings shall be provided to support the top head insulation where required.

F. Outdoor installations require a weather barrier for protection of the insulation jacketing.

G. Insulation types materials shall be suitable for temperatures encountered by each item of equipment.

2.05. ACCESSORY MATERIALS

A. Accessory materials installed as part of insulation work under this section shall include, but not be limited to:

1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.

2. Field-applied jacketing materials - sheet metal, plastic, canvas, fiber glass cloth, insulating cement; PVC fitting covers, PVC jacketing.

3. Support Materials - Hanger straps, hanger rods, saddles.

4. Fasteners, weld pins/studs, speed clips, insulation washers.

5. Metal mesh or expanded metal lagging.

B. All accessory materials shall be installed in accordance with project drawings and specifications, manufacturer's instructions, and/or in conformance with the current edition of

the Midwest Insulation Contractors Association (MICA) "Commercial & Industrial Insulation Standards."

2.06. FIELD-APPLIED JACKET

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

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a). Johns Manville; Zeston.
   b). P.I.C. Plastics, Inc.; FG Series.
   c). Proto PVC Corporation; LoSmoke.
   d). Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer. VOC content not to exceed 250 g/L.

3. Color: High Gloss White

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a). Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

PART 3. EXECUTION

3.01. WORKMANSHIP

A. The Contractor shall take special care to prevent soiling equipment below or adjacent to areas being insulated. He shall be completely responsible for removing insulation cement splashes and smears and all surfaces that he mars or otherwise soils or defaces, and he will be totally responsible for restoring these damaged surfaces to their like-new condition when delivered to the site.

3.02. SITE INSPECTION

A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.

B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project

comply with applicable specifications and standards and meet specified thermal and physical properties.

3.03. PREPARATION

A. Ensure that all pipe and equipment surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of piping systems has been completed prior to installing insulation.

3.04. INSTALLATION

A. Piping Systems

1. General:

a). Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.

b). Install insulation on piping subsequent to installation of heat tracing, painting, testing, and acceptance tests.

c). Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.

d). Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tear or other damage. Seal all tears, punctures and other penetrations of the pipe insulation vapor barrier facing.

e). On exposed piping, locate insulation and cover seams in least visible location.

2. Fittings: Cover valves, fittings, unions, flanges, strainers, flexible connections, expansion joints, pump bodies, strainers, blowdowns, backflow preventers, autoflow valves and similar items in each piping system using one of the following:

a). Mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs.

b). Insulation cement equal in thickness to the adjoining insulation.

c). PVC fitting covers insulated with material equal in thickness and composition to adjoining insulation.

3. Penetrations: Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise specified.

4. Joints:

a). Butt pipe insulation against hanger inserts. For hot pipes, apply 3-inch (7.5cm) wide vapor barrier tape or bank over butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints, and seal joints with 3-inch (7.5cm) wide vapor barrier tape or band.

b). All pipe insulation ends shall be tapered and sealed, regardless of service.

B. Equipment Insulation:

1. General:

a). Install insulation in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.

b). Install insulation on equipment after installation of heat tracing, painting, testing, and acceptance tests.

c). Install insulation materials with smooth, even surfaces. Rework poorly fitted joints. Do not use joint sealer or mastic as filler for joint gaps and excessive voids resulting from poor workmanship. Apply insulation using staggered joint method for both single and double layer installation, applying each layer of insulation separately.

d). Coat insulated surfaces where specified on contract drawings with layer of insulating cement, troweled in a workmanlike manner, leaving a smooth and continuous surface. Fill in seams, broken edges, and depressions. Cover over wire mesh and joints with cement sufficiently thick to remove surface irregularities.

e). Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. Seal all tears, punctures and other penetrations of equipment insulation facing.

f). Where specification calls for field-applied all-service vapor barrier jacketing, it shall be neatly fitted and tightly secured. Lap seams 2-inches (5cm) (min.). Seal all joints with adhesive. Tape with 3-inches (7.5cm) matching pressure-sensitive tape or 3-inch (7.5cm) glass fabric and mastic.

g). On exposed equipment, locate insulation and cover seams in least visible location.

2. Removable Insulation: Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance, such as vessel covers, fasteners, flanges, frames accessories, manholes, handholes, cleanouts ASME stamp, and manufacturer nameplates.

3. Areas Left Uninsulated: Items such as manholes, handholes, clean-outs, ASME stamp, and manufacturers' nameplates should be left uninsulated unless omitting insulation would cause a condensation problem. When such is the case, provide removable insulation and appropriate tagging to identify the presence of these items. Provide neatly beveled edges at interruptions of insulation.

4. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of weather barrier mastic protective finish or jacketing as recommended by the jacketing manufacturer.

3.05. FIELD QUALITY ASSURANCE

A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.06. PROTECTION

A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

B. The insulation contractor shall advise the general and/or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

3.07. SAFETY PRECAUTIONS

A. Insulation contractor's employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.

B. The insulation contractor shall conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.08. INSULATION COVERING

A. Unless otherwise noted, all exposed equipment insulation shall have a field applied PVC jacket cover neatly cut and pasted over equipment insulation. PVC shall be high gloss white and shall be 20 mils thick. Exposed areas include, but are not limited to, all mechanical equipment rooms, janitor’s closets, utility rooms, electric rooms, and piping and ductwork exposed in an occupied space.

B. Unless otherwise noted, all exposed pipe insulation required to be insulated shall be jacketed with a PVC Jacketing with fitting covers. PVC jacket shall be color fade resistant, white high gloss, U.S.D.A. authorized as manufactured by Proto Corporation or approved equal. PVC jacketing shall be high impact, ultraviolet resistant PVC. Minimum thickness shall be 20 mils, roll stock ready for shop or field cutting and forming.

C. Where PVC jackets are indicated, install with 1 inch overlap at longitudinal seams and end joints, for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.

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

END OF SECTION

DIVISION 22 SECTION 22 40 00
PLUMBING FIXTURES

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SECTION 224000

PLUMBING FIXTURES

PART 1. GENERAL

1.01. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers, and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

3. Product data for Credit WE 3: For water closets, urinals, documentation indicating flush rate in gallons per flush (gpf); for faucets and showerheads, documentation indicating flow rate in gallons per minute (gpm).

1.02. GENERAL

A. For General Mechanical Requirements, see Division 22 Section, *Common Work Results for Plumbing* & Division 01, *General Requirements.*

B. Drawings and general provisions of the Contract, including *General and Supplementary Conditions* and Division 01 specifications apply to this Section.

C. All exposed bolts, screws, etc., shall be vandal proof.

D. All plumbing materials, equipment and fixtures shall be new and of best grade, free of defects and complete with all required appurtenances and accessories.

E. Piping and insulation are specified under other sections.

F. Use "Sani-Sett" setting compound for fixtures.

G. Provide all materials, equipment and perform all labor required to install plumbing system complete as specified, as drawings indicated and as required by the State of Delaware, National Standard Plumbing Code and International Plumbing Code, City of Dover, local

code, and all other authorities have jurisdiction. Comply with the current lead free laws per the requirements of the state in which the project is being constructed.

H. Provide stops for all plumbing fixtures and equipment. Stops are to be accessible.

I. Provide P traps on fixtures for which traps have not been included as part of furnished equipment. Trap size to equal size of fixture tailpiece.

J. All exposed metal parts of fixtures shall be chromium plated brass. Piping, fittings, valves, traps and accessories including escutcheons for piping shall be chromium plated where exposed in finished areas.

K. All faucets for residential kitchen sinks, lavatories, drinking fountains, and ice makers shall be listed for drinking-water or commercial applications by the National Sanitation Foundation (NSF) or Underwriters Laboratory (U.L.). All required faucets shall comply with NSF Standard 61 for both lead content and leaching rate. Submit documentation indicating compliance for all required faucets.

L. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:

1. National Sanitation Foundation (NSF).
2. American Society of Mechanical Engineers (ASME).
3. National Electrical Manufacturers' Association (NEMA).
4. Underwriters Laboratories (UL).

1.03. REFERENCES

A. ANSI/ASME A112.6.1 - Supports for Off-the-floor Plumbing Fixtures for Public Use.

B. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.

C. ANSI/ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.

D. ANSI/ASMI A112.19.2 - Vitreous China Plumbing Fixtures.

E. ANSI/ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.

F. ANSI/ASME A112.19.5 -Trim for Water-Closet Bowl, Tanks, and Urinals (Dimensional Standards).

G. ANSI/ARI 1010 - Drinking-Fountains and Self- Contained, Mechanically-Refrigerated Drinking-Water Coolers.

H. ANSI/NFPA 70 - National Electrical Code.

I. IBC - International Building Code

1.04. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01, Section *General 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.

1.05. FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings and per the manufacturer.

B. Confirm that millwork is constructed with adequate provisions for the installation of counter top lavatories and sinks.

1.06. EXTRA MATERIALS

A. Provide two sets of faucet washers and flush valve service kits to the Owner. Provide correspondence to Engineer that extra materials have been turned over to the Owner.

1.07. GRAB BAR COORDINATION

A. For handicapped plumbing fixtures coordinate location of flush valves with grab bars prior to installation.

1.08. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

1.09. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

PART 2. PRODUCTS

2.01. PLUMBING FIXTURES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   1. Water Closets, Urinals and Lavatories: Kohler, Crane, American Standard, Falcon, Waterles, Sloan, Zurn.
   2. Water Closet Seats: Kohler, Church, Comfort Seats, Bemis.
   3. Faucets: Chicago Faucet, Kohler, Delta, Speakman, Symmons, T&S Brass, Zurn, Moen
   4. Drains: Chicago Faucet, Engineered Brass Co., Kohler, McGuire
   5. Stops & Supplies: Chicago Faucet, T&S Brass, McGuire, Brass Craft
   6. Flush Valves: Sloan, Delany, Zurn, Toto
   7. Traps: Kohler, McGuire, Dearborn, Engineered Brass Co. (17 gauge min.)

8. Carriers & Supports: Zurn, Josam, J. R. Smith, Mifab, Watts
9. Sinks: Elkay, Just, American Standard
10. Mop Sinks: Stern-Williams, Fiat, Acorn
11. Showers: Powers, Leonard, Speakman, Symmons
12. Electric Water Coolers/Drinking Fountains: Haws, Elkay, Oasis, Halsey Taylor, Acorn
13. Aerators/Shower Heads: Bricor, Neoperl, Omni Flow Controls

A. P-1

1. Watercloset (Infra-red): (battery powered) (wall hung, flush valve with manual override button) Kohler Model K-4325 Kingston Water-Guard Toilet, vitreous china, American Standard 3351, elongated bowl design, siphon jet flushing, wall hung with bolt caps, seat, carrier, supplies and stops.

2. Flushometer: Sloan Model Regal Pro #8111 Optima Plus, Delany, Zurn, American Standard 6065, or approved equal, low consumption (1.28 GPF), exposed diaphragm type, chrome plated brass, battery powered, sensor operated closet flushometer. Unit shall include the following features and accessories: ADA compliant battery powered infrared sensor for automatic "no hands" operation, courtesy flush override button, "low battery" flashing LED, infrared sensor range adjustment screw, initial set-up range indicator light, four (4) size AA batteries, 1-inch I.P.S screwdriver back check angle stop, locking vandal resistant stop cap, sweat solder adapter with cover tube and cast set screw wall flange, adjustable tail piece, vacuum breaker flush connection with one piece bottom hex coupling nut, spud coupling and flange for 1 ½ -inch top spud. Supply with Sloan Model J-212-A, American Standard 6065.862, split ring wall support. Provide 3 year limited Manufacturer's warranty.

3. Seat: Kohler Model K4670-C, American Standard 5901.100, solid plastic white seat with open front and check hinge.

4. Carrier: Zurn, Josam or Watts cast iron watercloset Carrier with fittings as required. ANSI/ASME A112.6.1 adjustable cast iron frame integral drain hub and vent, adjustable speed, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

B. P-1A

1. Watercloset (Handicapped) (Infra-red): (battery powered) (wall hung, flush valve with manual override button) Kohler Model K-4325 Kingston Toilet, American Standard 3351, vitreous china, elongated bowl design, siphon jet flushing, wall hung with bolt caps, seat, carrier, supplies and stops.

2. Flushometer: Sloan Model Regal Pro #8111 Optima Plus, Delany, Zurn, American Standard 6065, or approved equal, low consumption (1.28 GPF), exposed diaphragm type, chrome plated brass, battery powered, sensor operated closet flushometer. Unit shall include the following features and accessories: ADA compliant battery powered infrared sensor for automatic "no hands" operation, courtesy flush override button, "low battery" flashing LED, infrared sensor range

adjustment screw, initial set-up range indicator light, four (4) size AA batteries, 1-inch I.P.S screwdriver back check angle stop, locking vandal resistant stop cap, sweat solder adapter with cover tube and cast set screw wall flange, adjustable tail piece, vacuum breaker flush connection with one piece bottom hex coupling nut, spud coupling and flange for 1 ½-inch top spud**.** Supply with Sloan Model J-212-A split ring wall support. Provide 3 year limited Manufacturer's warranty. Maximum height to top of flush valve shall be 16 - ½".

3. Seat: Kohler Model K4670-C solid plastic white seat with open front and check hinge.

4. Carrier: Zurn, Josam or Watts cast iron watercloset Carrier with fittings as required. ANSI/ASME A112.6.1 adjustable cast iron frame integral drain hub and vent, adjustable speed, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

C. P-2

1. Urinal (Infra-red): (Battery powered, flush valve with manual override button) Kohler model K-4960-ET Bardon water guard, American Standard 6506.010, urinal, vitreous china, washout design, 3/4-inch top spud inlet, 2-inch outlet and carrier.

2. Flushometer: Sloan Model Regal Pro #8186-1.0-OR, Delany, Zurn, American Standard 6063.101, or approved equal, low consumption (pint flush), exposed diaphragm type, chrome plated brass, battery powered, sensor operated urinal flushometer. Unit shall include the following features and accessories: ADA compliant battery powered infrared sensor for "no hands" operation, "low battery" flashing LED, infrared sensor range adjustment screw, initial set-up range indicator light, four (4) size AA batteries, courtesy flush override button, ¾ -inch I.P.S. screwdriver back check angle stop, locking vandal resistant stop cap, sweat solder adapter with cover tube and cast set screw wall flange, adjustable tail piece, vacuum breaker flush connection with one piece bottom hex coupling nut, spud coupling and flange for ¾ -inch top spud. Sloan Model J-212-A split ring wall support. Provide 3 year limited Manufacturer's warranty.

3. Carrier: Zurn, Josam or Watts cast iron urinal carrier with fittings as required. ANSI/ASME A112.6.1A; cast iron and steel frame with tubular legs, legs for floor and wall attachment, threaded fixtures studs for fixture hanger, bearing studs.

D. P-2A

1. Urinal (Handicapped) (Infra-red); (Battery powered, flush valve with manual override button) Kohler model K-4960-ET Bardon water guard, American Standard 6506.010, urinal, vitreous china, washout design, 3/4-inch top spud inlet, 2-inch outlet and carrier. Fixture lip mounted 17-inches above finished floor. Unit and installation shall comply with the American Disabilities Act Guidelines and ANSI A117.1 requirements for people with disabilities.

2. Flushometer: Sloan Model Regal Pro #8186-1.0-OR, Delany, Zurn, American Standard 6063.101, or approved equal, low consumption (pint flush), exposed

diaphragm type, chrome plated brass, battery powered, sensor operated urinal flushometer. Unit shall include the following features and accessories: ADA compliant battery powered infrared sensor for "no hands" operation, "low battery" flashing LED, infrared sensor range adjustment screw, initial set-up range indicator light, four (4) size AA batteries, courtesy flush override button, ¾-inch I.P.S. screwdriver back check angle stop, locking vandal resistant stop cap, sweat solder adapter with cover tube and cast set screw wall flange, adjustable tail piece, vacuum breaker flush connection with one piece bottom hex coupling nut, spud coupling and flange for ¾-inch top spud. Sloan Model J-212-A split ring wall support. Provide 3 year limited Manufacturer's warranty.

3. Carrier: Zurn, Josam or Watts cast iron urinal carrier with fittings as required. ANSI/ASME A112.6.1A; cast iron and steel frame with tubular legs, legs for floor and wall attachment, threaded fixtures studs for fixture hanger, bearing studs.

E. P-3

1. Lavatory (Infra-red): (wall hung) (battery operated) Chicago faucet, Kohler Model K-2032 Greenwich, American Standard Lucerne 0356.421, wall mount lavatory, vitreous china with 20-inch x 18 bowl, and 4-inch faucet centers. Provide concealed arm Carrier.

2. Faucet: Provide sensor operated faucet. Sensor operated faucet shall be Chicago Faucet Model 116.606.AB.1 with integral 4” center body, sensor and solenoid above deck within faucet, filter, chrome finish and vandal resistant. Unit shall operated on 6 VDC lithium (included). Unit shall include integral check cartridges, 0.5 GPM E2805 vandal proof outlet.

3. Thermostatic Mixing Valves: Provide and install below fixture. See Part 2 “Thermostatic Mixing Valves”.

4. Strainer: Chicago Faucet Model 327A, American Standard 2411.015 with 1 ¼ inch tailpiece, non removable brass strainer, grid strainer waste, chrome plated finish.

5. P-Trap: Chicago Faucet Model 337, American Standard 7723.018 offset drain assembly.

6. Stops: Chicago Faucet Model 1005ABCP valve stops with 3/8-inch loose key cap and removable tee handle, wall flange, chrome plated finish.

F. P-3A

1. Lavatory (Infra-red) Handicapped: (wall hung) (battery operated) Chicago faucet, Kohler Model K-2032 Greenwich, American Standard Lucerne 0356.421, wall mount lavatory, vitreous china with 20-inch x 18 bowl, and 4-inch faucet centers. Provide concealed arm Carrier.

2. Faucet: Provide sensor operated faucet. Sensor operated faucet shall be Chicago Faucet Model 116.606.AB.1 with integral 4” center body, sensor and solenoid above

deck within faucet, filter, chrome finish and vandal resistant. Unit shall operated on 6 VDC lithium (included). Unit shall include integral check cartridges, 0.5 GPM E2805 vandal proof outlet. Unit shall be ADA compliant.

3. Thermostatic Mixing Valves: Provide and install below fixture. See Part 2 "Thermostatic Mixing Valves".

4. Lavatory Protective Enclosure: Provide and install Truebro Model # 2018 lav shield lavatory enclosure on all lavatories with sensor operated faucets. Protective enclosure shall be ADA conforming, 20-inch x 18-inch wheel chair accessible. Unit shall have white finish, be constructed of high impact, stain resistant vinyl, and include seven (7) wall anchors.

5. Strainer: Chicago Faucet Model 327A, American Standard 2411.015 with 1 ¼ inch tailpiece, non removable brass strainer, grid strainer waste, chrome plated finish.

6. P-Trap: Chicago Faucet Model 337, American Standard 7723.018 offset drain assembly.

7. Stops: Chicago Faucet Model 1005ABCP valve stops with 3/8-inch loose key cap and removable tee handle, wall flange, chrome plated finish.

G. P-4

1. Mop Receptor (Floor Unit) (36-inch X 24-inch): Stern Williams 'ELFIN" Model EBR-66, Flat SBC3636, or approved equal, 36-inch x 24-inch x 6-inch dimensions. Shoulders shall be not less than 3-3/4 -inch high inside measurement, and not less than 1 -1/4-inch wide. Unit shall be constructed of Terrazzo composed of pearl grey marble chips in white portland cement, designed to develop a compressive strength of 3000 psi seven days after casting. Unit shall be ground smooth, grouted and sealed to resist stains. Furnish unit with cast brass drain with stainless steel strainer cast integral and 3-inch caulk connection. Furnish unit with anodized extruded aluminum bumper guard for exposed sides. Provide and install stainless steel BP splash catcher panels on adjacent walls.

2. Faucets: Chicago faucet 897-RCF(rough chrome finish), Speakman SC-5811-RCD, American Standard 8344.112.004, or approved equal with cast brass, chrome plated body, vacuum breaker spout, stops in arms. Faucet shall include 3/4-inch hose thread outlet, Pail Hook, and wall brace

H. P-5

1. Electric Water Cooler (Dual Height) (Handicapped) Recessed Unit: Haws Model H1011.8, Acorn or approved equal, Barrier-free, dual height unit with mounting frame. Air cooled electric water cooler shall be capable of delivering 8 GPH at 90 degrees F ambient 80 degrees F, inlet water and 50 degrees F outlet drinking water. Top shall be stainless steel; bubblers shall be one piece, polished chrome plated with anti-squirt angle stream cabinet shall be No. 4 Satin finish stainless steel. Unit shall be supplied with junction box for field wiring of unit. Lower spout outlet shall be mounted 36 inches above finished floor. Upper spout outlets shall be mounted 40-

inches above finished floor. Water cooler and installation shall conform to all requirements of American Disabilities Act Guidelines and ANSI A117.1.

2. Refrigerant shall be R-134a or equivalent environmentally friendly refrigerant.

3. Provide Carrier as manufactured by Zurn, Josam, Amcon, Smith, Mifab, or approved equal.

I. P-5A

1. Exterior Drinking Fountain (Non Freeze Type) (Dual Height/Handicapped Outdoor Wall Mounted): Acorn AIG2400B-BP6 or approved equal, wall mounted, vandal resistant bi-level square drinking fountain made from 18 gauge, 304 stainless steel bowls mounted into stainless steel, heavy duty, 11 gauge galvanized support arms with a stainless steel back panel. Unit shall be activated by front mounted self-closing buttons, by using less than 5 pounds of force which activates internally mounted valves with adjustable stream regulators controlling the water flow. Bubbler head shall be polished chrome plated brass, with non-squirt features and shall operate on water pressure range of 20-105 psig. Drinking fountain and installation shall conform to all requirements of American Disabilities Act Guidelines and ANSI A117.1. Unit shall be resistant to sunlight, heat, moisture, and water. Furnish unit with 100 mesh inlet strainer, freeze resistant valve system, vandal resistant bottom galvanized steel plate, screws, and mounting plate.

2. Carrier: Furnish each unit with Model CSC concealed support carrier.

J. P-6

1. Hand Wash Sink: Hand wash sink provider under another Division of these specifications. Under this division, provide rough-in and final connection. Furnish and install a thermostatic mixing valve below fixture. See Part 2 “Thermostatic Mixing Valves”.

K. P-7

1. Shower: Enclosure by other. Provide floor drains as specified on contract drawings. Provide rough-in and final connections of cold water, hot water, vent, and waste. Provide and install Powers Process Controls P902H pressure balance shower valve with check stops and 3 ports for shower application. Unit shall include showerhead, arm and flange. Provide round face plate with red/blue indication insert. Escutcheon shall be chrome plated stainless steel. Furnish each shower with a Speakman, Bricor, Chronomite or approved equal low flow (1.0 GPM) showerhead.

2. Shower Head: Bricor, Speakman, Chronomite, or approved equal low flow (1.0 GPM at 30 psig) wall mounted shower head with water conserving pressure compensating autodevice.

L. P-7A

1. Shower (Roll-In) (Handicapped): Enclosure and surrounding shower walls are provided under the Architectural Division of these specifications. Provide floor drains as specified on Contract Drawings. Provide rough-in and final connection of cold water, hot water, vent, and waste. Furnish and install Speakman Model VS-1970, Powers Process Controls P902H or approved equal pressure balance shower valve with check stops and three (3) ports for shower application. Unit shall include shower head, arm, flange, transfer valve, and hand held combination unit. Unit shall include Speakman Bricor, Chronomite or equivalent low flow (1.0 GPM) wall mounted shower head with water conserving pressure compensating auto device. Provide standard 69-inch white vinyl reinforced hose, chrome plated brass supply with wall flange, 44-inch slide bar with adjustable upper bracket and mounting screws. Hand held shower shall include in-line vacuum breaker and quick disconnect for storage of hand held shower by Teachers. All exposed parts shall be polished chrome plated. Shower and installation shall conform to all requirements of American Disabilities ACT Guidelines and ANSI A117.1.

2. Shower Head: Bricor, Speakman, Chronomite, or approved equal low flow (1.0 GPM at 30 psig) wall mounted shower head with water conserving pressure compensating autodevice.

M. P-8

1. Two Compartment Sink: The two compartment sink shall be provided under another Division of these specifications. Provide rough-in and final connection under this Division.

N. P-9

1. Ice Maker: Provided in another Division of specifications. Under this Division provide rough-in and final connection including indirect waste outlet to floor sink and wall box.

2. Ice maker rough-in shall include a Guy Gray recessed ice maker wall box. Ice maker wall box shall be Model BIM875 or the approved equal of Watertight. Unit shall be complete with ½ -inch FIP inlet x ¼ -inch O.D. outlet compression angle valve. Overall dimensions shall not exceed 10 3/4-inch wide x 9-inch high x 3 5/8-inch deep. Box shall be 16 gauge steel finished in a white epoxy finish. Provide sufficient copper tubing from wall box to ice maker to allow movement without disconnecting ice maker from wall box.

3. Ice Maker Cold Water Inlet Filter

a). Contractor shall provide and install a cartridge type water filter on the cold water inlet to the owner furnished ice maker as detailed on the contract drawings. Housing shall be constructed of PVC with 3/4-inch NPT connections. Heads shall be cast bronze nickel plated with nickel plated "T" handle cap nut. Unit shall have pet cock bottom drain. Housing shall contain two (2) 20 micron cartridge filters. The entire filter assembly shall be rated for 150 psig. Unit shall be capable of handling a minimum 6 gpm. Housing shall be as manufactured by Keystone or approved equal.

b). Install filter housing to allow access for service and filter replacement.

2.02. THERMOSTATIC MIXING VALVES (INDIVIDUAL FIXTURE TYPE)

A. Furnish and install thermostatic mixing valves where indicated at public lavatories, and below handsinks.

B. Thermostatic mixing valves shall be Bradley S59-4000A, Watts, or approved equal for installation under lavs. Provide in-line check valves, lead free body, escutcheon plates, inlet filters, and insulation as required. Thermostatic mixing valves shall be adjusted to deliver 105 degrees Fahrenheit hot water when supplied with 140 degrees Fahrenheit delivering hot water. Furnish with adjusting cap with locking feature.

C. The thermostatic mixing valves shall be ASSE standard 1016-96, ASSE 1017, ASSE 1069, and ASSE 1070 listed.

2.03. PLUMBING FIXTURE SUPPORTS

A. Wall mounted urinal supports, Josam 17810 plate type with cast iron headers, box steel stanchions, block type cast iron feet with bearing plate.

B. Support for wall mounted urinals, lavatories, sinks, drinking fountains, etc.:

1. Where fixtures are supported from concrete or cinder block walls, install No. 10 USSG Steel plate on the opposite side of the wall and bolt hangers or supports through plate. Where opposite side of wall is exposed to view, place bolts in core of blocks and fill core with cement.

2. Where lavatories with wall hangers have been specified and fixtures are supported from metal stud frame partitions, fixture brackets or mounting lugs shall be through bolted to steel channel crosspieces not less than 1-1/2-inch wide anchored to studs. Bolt heads shall be welded to channel web.

3. Concealed arm type lavatory supports, Josam 17100 with cast iron headers, box steel stanchions, block type cast iron feet and header; and chrome plated cast brass threaded escutcheons for slab type lavatories.

4. Flush mounted drinking water cooler supports, Josam 17550 plate type, box steel stanchions, block type cast iron feet.

C. Water closet chair carriers, Josam 12000 Series for horizontal and vertical installations.

2.04. HANDICAPPED LAVATORY/SINK INSULATION

A. All handicapped lavatories and sinks shall be provided with under counter pipe and trim insulation.

B. Insulation shall be fully molded "P" trap and angle valve insulated Hand-I-Lav Guard, Truebro Model #101, 102, and 105 to suit.

C. Insulation to meet ADA #4 19.4, ANSI A117.1, and International Plumbing Code.

D. Self extinguishing ASTM D635 burn characteristics, thermal conductivity ASTM C177 K-Value ' 1.17.

E. Insulation thickness to be minimum 2 inch.

F. Where lav. Guards are provided insulation may be omitted.

PART 3. EXECUTION

3.01. GENERAL INSTALLATION REQUIREMENTS

A. Install all equipment in accordance with manufacturer's instructions.

B. Setting heights of lavatories, drinking fountains, etc., shall be as directed prior to installation and shall be coordinated with Architectural Contract Documents.

C. Install floor mounted fixtures only after finished floor has been installed.

D. Provide rubber concussion washers between vitreous china fixtures and supporting brackets.

E. Protect chromium plated trim from corrosive solutions used to clean tile work.

F. Provide white, silicone caulking where fixtures come in contact with walls and floors. Sealant shall be mildew resistant type in accordance with ANSI A-136.1.

G. Install components plumb and level.

H. Install and secure fixtures in place with wall supports, wall carriers and bolts.

I. Solidly attach water closets to floor with lug screws. Lead flashing is not intended to hold fixture in place.

J. Install flush valve handles on the open side of all ADA waterclosets in accordance with ANSI requirements.

K. Fixtures shall be vitreous china unless otherwise noted. Cast iron fixtures shall have acid resisting enamel finish unless noted otherwise, color shall be white.

L. Flush valves shall be self-closing, non-hold open type with vacuum breaker and perform satisfactorily when subject to inlet water pressure varying from 15 to 75 psi. Flush valves shall be as specified, Sloan, Delaney, Zurn, Toto, or approved equal.

M. Provide flexible risers and loose key stops for all lavatories and sinks. Provide 17 ga. chrome plated brass tail piece and trap with cleanout for all lavatories and sinks.

N. Fittings for fixtures supplied by others, such as kitchen equipment are provided under another division of these specifications. Connections of these fixtures to the plumbing

system are provided under this section.

O. Coordinate with plumbing piping and related electrical work to achieve a complete operating system.

P. All plumbing vents within a 10'-0" radius of exhaust vents shall be extended to a height of 3'-0" above exhaust vent crown.

Q. All plumbing vents within a 10'-0" radius of any rooftop unit or intake louver shall be extended to a height of 3'-0" above fresh air intake.

R. Slopes and invert elevations of all interior piping shall be established before any piping is installed in order that proper slopes will be maintained. All piping shall be located and determined where to be run to avoid conflict with other trades.

S. Unless otherwise noted, all plumbing piping shall be routed as high as possible between bottom of roof joists and above ceiling to allow proper installation of ductwork, fire protection piping, conduits, etc.

T. Coordinate with Architectural Drawings before roughing in plumbing.

U. All openings in ceilings and plenum walls for plumbing shall be sealed air tight and protected with fire stop.

V. See site plan for extent of all piping leaving and entering building.

W. See domestic water riser diagrams for location of valves, shock absorbers, etc.

X. Make proper HW, CW, re-cir., waste, and vent connections to all fixtures and equipment even though all branch main, elbows and connections are not shown.

Y. Unless otherwise noted, sanitary waste piping shown is below floor and all other piping is overhead, above ceiling. Domestic hot, cold and re-circ. water piping shall be installed between ceiling and attic insulation.

Z. Unless otherwise noted, horizontal sanitary piping shall be pitched 1 percent.

AA. Unless otherwise noted, all domestic water piping and fire protection piping shall be installed on heated side of ceiling insulation.

BB. All piping and installation shall comply with all local and national plumbing codes. Test piping as required by plumbing code and authority having jurisdiction.

CC. For sizes of all domestic water piping see plumbing fixture schedule and domestic water riser diagrams.

DD. For sizes of all sanitary and vent piping see plumbing fixture schedule and sanitary/vent riser diagrams.

3.02. PLUMBING SPECIALTY INSTALLATION REQUIREMENTS

A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.

B. Fasten recessed, wall-mounting plumbing specialties to reinforcement built into walls.

C. Secure supplies to supports or substrate.

D. Install individual stop valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve as appropriate is not indicated.

E. Install water-supply stop valves in accessible locations.

F. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

G. Include wood-blocking reinforcement for recessed and wall-mounting plumbing specialties.

3.03. FITTINGS FOR FIXTURES SUPPLIED BY OTHERS

A. Fixtures, such as a two compartment sink, are provided under other divisions of the specifications. Fittings, accessories and connection of these fixtures to the plumbing system are provided under this section.

B. Rough-in and final connection includes but is not limited to all domestic water, waste, and vent systems. Furnish stops, strainers, vacuum breakers, and under counter insulation where not furnished under another Division of these specifications.

3.04. TESTING

A. After plumbing fixtures are connected, all piping and fixtures shall be tested for operation and a smoke or peppermint test shall be made on all soil, waste and vent piping.

B. After the building has been occupied and the various equipment is in actual use, the Contractor shall make an operating test of all equipment at a time directed by the Engineer to determine that all contract requirements are met.

3.05. CLEANING AND STERILIZATION

A. After final testing for leaks, all potable water lines shall be thoroughly flushed, by plumbing contractor, to remove foreign material. Before placing the systems in service, sterilize the new water lines in accordance with local health department codes and at a minimum according to the following procedure:

1. Through a 3/4-inch hose connection in each branch main and building main, pump in sufficient sodium hypochlorite to produce a free available chlorine residual of not less than 200 ppm. Plumbing Contractor shall provide plumbing connections and power for pumping chlorine into system.

2. Proceed upstream from the point of chlorine application opening all faucets and taps until chlorine is detected. Close faucets and taps when chlorine is evident.

3. When chlorinated water has been brought to every faucet and tap with a minimum concentration of 200 ppm chlorine, retain this water in the system for at least three (3) hours.

4. CAUTION: Over-concentration of chlorine and more than three (3) hours of retention may result in damage to piping system. It is not necessary to retain chlorine in any system for twenty-four hours to achieve sterilization. AWWA states that 200 ppm chlorine for three hours is sufficient.

5. At the end of the retention period, no less than 100 ppm of chlorine shall be present at the extreme end of the system.

6. Proceed to open all faucets and taps and thoroughly flush all new lines until the chlorine residual in the water is less than 1.0 ppm.

7. Obtain representative water sample from the system for analysis by an independent and recognized bacteriological laboratory.

8. If the sample tested for coliform organisms is negative, a letter and laboratory report shall be submitted by the service organization to the Contractor, certifying successful completion of the sterilization. Additionally, this report shall be forwarded to the Owner as well as be included in the O&M Manual.

9. If any samples tested indicate the presence of coliform organisms, the entire sterilization procedure shall be repeated.

10. Take precautions to avoid use of plumbing fixtures and domestic water systems during sterilization period. Place signs on all plumbing fixtures and outlets during sterilization period.

3.06. EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

3.07. PREPARATION

A. Confirm rough-in location and size of fixtures and openings prior to commencing work.

B. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.08. INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.09. ADJUSTING

A. Adjust stops, valves, infrared fixtures for intended water flow rate to fixtures without splashing, noise, or overflow.

3.10. CLEANING

A. At completion, clean plumbing fixtures and equipment. Polish all chrome plated faucets, accessories, equipment, and piping.

B. All electric water cooler coils shall be cleaned of all construction dust and debris prior to building occupation by Owner.

3.11. FIXTURE HEIGHTS

A. Install fixtures to heights above finished floor as required by local Plumbing Code, Americans with Disabilities Act (A.D.A.), Authority Having Jurisdiction, and Architectural Contract Drawings. In the absence of a local code requirements, install fixtures to heights above finished floor as follows.

B. Water Closet

1. Standard 15 inches to top of bowl rim.
2. Handicapped 18 inches to top of seat.

C. Urinal

1. Standard 22 inches to top of bowl rim.
2. Handicapped 17 inches to top of bowl rim.

D. Lavatory

1. Standard 31 inches to top of basin rim.
2. Handicapped 34 inches to top of basin rim.

E. Drinking Fountain

1. Standard 36 inches to top of basin rim.
2. Handicapped 34 inches to top of basin rim.

F. Water Closet Flush Valves

1. Standard 11 inches min above bowl rim.
2. Recessed 10 inches min. above bowl rim.

G. Shower Heads

1. Adult male 69.5 inches to bottom of head.
2. Adult female 64.5 inches to bottom of head.

3. Handicapped (unisex) with handheld 76 inches to top of head arm.

END OF SECTION

DIVISION 22 SECTION 22 40 05
PLUMBING EQUIPMENT

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SECTION 22 40 05

PLUMBING EQUIPMENT

PART 1. GENERAL

1.01. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers, and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

1.02. GENERAL

A. For General Mechanical Requirements, see Division 22 Section, *Common Work Results for Plumbing* & Division 01, *General Requirements.*

B. Drawings and general provisions of the Contract, including *General and Supplementary Conditions* and Division 01 specifications apply to this Section.

C. All exposed bolts, screws, etc., shall be vandal proof.

D. All plumbing materials and equipment shall be new and of best grade, free of defects and complete with all required appurtenances and accessories.

E. Piping and insulation are specified under other sections.

F. Provide all materials, equipment and perform all labor required to install plumbing system complete as specified, as drawings indicated and as required by the State of Delaware, National Standard Plumbing Code , International Plumbing Code, City of Dover Code, the local code, and all other authorities have jurisdiction.

G. Provide stops for all plumbing equipment. Stops are to be accessible.

H. Provide pumps with manufacturer's name, model number, and rating/capacity identified.

I. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:

1. National Sanitation Foundation (NSF).
2. American Society of Mechanical Engineers (ASME).
3. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
4. National Electrical Manufacturers' Association (NEMA).
5. Underwriters Laboratories (UL).

J. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitations, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.03. REFERENCES

A. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.

B. ANSI/ASE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.

C. ANSI A112.21.1 - Floor Drains.

D. ANSI A112.21.2 - Roof Drains.

E. ANSI A112.26.1 - Water Hammer Arrestors.

F. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.

G. PDI WH-201 Water Hammer Arresters.

H. ANSI/ASHRAE 90A - Energy Conservation in New Building Design.

I. ASME Section VIIID - Pressure Vessels; Boiler and Pressure Vessel Codes.

J. ANSI/NFPA 70 - National Electrical Code.

K. ANSI/NEMA 250 - Enclosure for Electrical Equipment (1000 Volts Maximum).

L. IBC - International Building Code

1.04. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of General Requirements.

B. Accept equipment on site in factory packaging. Inspect for damage.

C. Protect installed equipment from damage by securing areas and by leaving factory packaging in place to protect equipment and prevent use.

1.05. FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings and per the manufacturer.

1.06. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

1.07. LEED REQUIREMENTS

A. Refer to Division 01 Section, "LEED Requirements" for description of work under this Division affected by LEED requirements.

1.08. LEAD FREE REQUIREMENTS

A. All plumbing fixtures, equipment, and devices that contact potable water must be lead free per the State requirements.

PART 2. PRODUCTS

2.01. FLOOR AND ROOF DRAINS

A. Provide Nikaloy strainers on all floor drains unless specified otherwise.

B. Provide flashing clamps on all drains penetrating waterproofing membrane.

C. Provide suitable flashing material and clamping collar for drains which are not set in place when slab is poured.

D. Provide backwater valves for all floor drains connecting directly to the storm water system. Depending on conditions of the particular installation backwater valves may be an integral part of the drains or a separate device. Accessibility to valves must be maintained for maintenance. Provide an adequately sized extension sleeve up to floor or grade as required.

E. Backwater valves are normally closed, flapper type with bronze or brass seat and disc and stainless steel pin.

F. Provide traps for all floor drains connected to the sanitary system.

G. All priming lines shall be connected to automatic trap primer. All floor drains shall be connected to trap priming stations.

H. Provide Josam 26200 vertical expansion joint in each rain leader that does not have 90 degrees offset downstream of the roof drain. The expansion sleeve shall be bronze and shall conduct the rain water beyond the packing. Install expansion joints in accessible locations for repacking.

I. In lieu of joints specified in piping section, neoprene gaskets may be used if designed for use with the drains and cleanouts employed and if approved by the local plumbing authority.

J. Schedule of Drains and Accessories:

1. RDR.-1: Roof Drain: Zurn Z-100 15-inch diameter roof drain, dura coated cast iron body with combination membrane flashing clamp/gravel guard and low silhouette aluminum locking dome. Provide with support ring, adjustable top with wide roof flange, large sump with anchor flange, bottom outlet inside caulk connection and deck clamp. Provide overflow drain as detailed on contract drawings.

2. FDR.-1: General Service Floor Drain: Zurn ZN-415 floor and shower drain, dura coated cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with Type "B" polished nickel bronze strainer. Provide with ½ -inch trap primer connection.

3. FDR.-2: Mechanical Room Floor Drain: Zurn Z-566 12-inch square open top drain, dura coated cast iron body with bottom outlet, ½ top grate, large suspended cast iron sediment bucket. Provide flashing flange and ½" -inch trap primer connection.

4. FDR.-3: Floor Sink: Zurn Z-1920 Sani-Flor recptor, 16-inch x 16-inch x 7-inch depp cast iron body and ssquare slotted heavy duty grate, with white acid resisting coated interior and top, complete with aluminum anti splash interior bottom dome strainer. Provide two (2) removable ½ grates with each unit. Provide with ½ inch trap primer connection. Provide stainless steel mesh bucket screen with each floor sink.

K. Approved Manufacturers: Josam, J.R. Smith, Zurn, Wade, Ancon, Mifab, Watts.

2.02. CLEANOUTS

A. Provide cleanouts in sanitary and storm drainage systems at ends of runs, at changes in direction, near the base of stacks, every 50 feet in horizontal runs, of 4-inch diameter or less, every 100 feet in horizontal runs over 4-inches, and where indicated.

B. Cleanouts shall be full size of pipe up to 4-inches and shall be 4-inches for larger sizes. Where installed in finished floors inserts shall match adjacent floor construction.

C. Materials and Approved Manufacturers: Josam, J.R. Smith, Zurn , Wade or Ancon, Mifab, Watts, equal to Josam numbers given below:

1.	Concealed Piping	C.I. Pipe
2.	Unfinished Areas	
3.	Floors	56070
4.	Walls	58790
5.	Finished Areas - Floors	
6.	Terrazzo	56040-13
7.	Composition Tile	56000-12
8.	Ceramic Tile	56000
9.	Carpet	56070-14

10. Carpet insert to match adjacent carpet in type, color and grade.

11. Finished Areas - Walls

12.	Plaster/Dry Wall	58770
13.	Tile/CMU	58790

2.03. WALL HYDRANTS

A. Wall Hydrant (Exterior): Josam 71000 Series Hydrasan anti-siphon wall hydrant, 3/4-inch non-freeze, key operated wall hydrant with hinged locking cover, polished bronze box and cover and bronze casing and integral vacuum breaker. Seat and disc shall be removable from front of the hydrant. Wall thickness; see architectural drawings. Wall hydrants shall conform to ANSI/ASSE 1019 with wall plate, lock shield and removable key.

B. Approved Manufacturers: Josam, Wade, Zurn, J.R. Smith, Mifab, Watts, or approved equal.

2.04. SHOCK ABSORBERS

A. Provide shock absorbers equal to Josam Shokstops at all fast closing valves, at the top of all cold water risers, at each flush valve or battery of flush valves, and where indicated. Sizes and locations shall be in accordance with PDI Standard WH 201.

B. Shock absorbers shall conform to ANSI A112.26.1, precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psig working pressure.

C. Approved Manufacturers: Josam, Wade, Zurn, J.R. Smith, Sioux Chief, Watts, or approved equal.

2.05. VACUUM BREAKERS

A. Provide vacuum breakers on water connections to fixtures and equipment where minimum air gaps required by Plumbing Code are not possible and on hose bibbs and other outlets to which hoses can be attached.

B. Vacuum breakers not subject to back pressure, Watts No. 288A; vacuum breakers subject to back pressure, Watts Series 9D or for hose threads, Watts Series 8A.

C. Hose connection backflow preventers shall be ASSE 1052, suitable for at least 5 gpm flow and applications with up to 10 foot head back pressure. Include two (2) check valves, intermediate atmospheric vent, and non-removable, ASME B1.20.7 garden-hose thread on outlet.

D. Hose connection vacuum breakers shall be ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7 garden-hose threads on outlet. Units attached to rough-bronze finish hose connections may be rough bronze.

E. Approved manufacturers: Watts, Beeco, B&K Industries, Zurn, Sparco, Conbraco or approved equal.

2.06. HOSE BIBBS

A. Chicago Faucet No. 952 or approved equal hose and faucet. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose threaded spout, polished chrome plated where exposed in finished areas, with hand wheel and removable key, integral vacuum breaker in conformance with ANSI/ASSE 1011.

B. Hose bibbs in finished areas shall be polished chrome finish.

C. Approved Manufacturers: Chicago Faucet, American Standard, Crane, T&S Brass, Watts.

2.07. DOMESTIC WATER CARTRIDGE TYPE RE-CIRCULATING PUMPS

A. Provide and install domestic water re-circulating pumps of the size, capacity and electrical characteristics as indicated on the contract drawings. Pumps shall be in-line cartridge circulators as manufactured by TACO, Bell and Gossett, Thrush, Armstrong, or approved equal. Units shall be U.L. listed.

B. Pumps shall be non-overloading throughout the range of the curves. Pumps shall have center line discharge for positive venting, flanged bodies, and same size suction and discharge.

C. Motors shall be permanent split capacitor with built-in overload protection. Impellers shall be non-metallic. Casings shall be bronze construction. Shafts shall be ceramic with carbon bearings. Units shall be rate for 125psi maximum pressure and 220 degrees F maximum temperature.

D. All circulators utilized for domestic water service shall be all bronze construction or stainless steel construction. Shaft orientation and junction box orientation shall be installed per manufacturer's recommendations.

2.08. BACKWATER VALVES

A. Backwater valves shall be provided at all connections of floor drains to stormwater piping systems and where indicated on contract drawings.

B. Backwater valves shall be ANSI A112.21.2, galvanized cast iron body and cover, brass valve, access cover, extension sleeve and cover.

C. Backwater valves shall be equal to Josam 67520-15.

D. Extend access cover to finished floor and terminate in cleanout.

E. Approved Manufacturers: Josam, Zurn, Wade, Smith, Ancon or approved equal.

2.9. ELECTRIC DOMESTIC WATER HEATER

A. Furnish and install electric water heaters of the size, capacity, and arrangements indicated on the Contract Drawings. Heater shall be A. O. Smith Model DEN/DEL, Lochinvar, State, Bradford White, or approved equal. Water heaters shall be UL listed. The domestic water heater and installation shall meet all requirements of the State of Maryland Boiler and

Pressure Vessel Safety Act and Regulations including amendments and addenda latest edition. The domestic water heater and installation shall comply with all requirements of the local Boiler Inspector. Contractor must submit any deficiencies cited by the Boiler Inspector to the Engineer and Owner for review.

B. Tanks shall be glass lined with magnesium anode and an approved working pressure of 150 psi. Tank shall have a steel jacket with a baked enamel finish. Electric elements shall be screw in design complete with adjustable thermostatic controls. Tank shall be insulated to conform with latest ASHRAE 90 Standards.

C. Accessories shall include an A.S.M.E. rated temperature/pressure relief valve, drain valve, electrical junction box, and terminal block.

D. Install water heaters on 4 inch high concrete housekeeping pad unless otherwise detailed on the drawings.

2.10. BACKFLOW PREVENTER (DOUBLE CHECK VALVE ASSEMBLY TYPE) (VERTICAL TYPE)

A. Furnish and install double check valve assembly backflow preventers at incoming water services and where else indicated on contract documents.

B. The assembly shall consist of two positive seating check modules with captured springs and rubber seat discs. The check module sets and seat discs shall be replaceable.

C. Service of all internal components shall be through a single access cover secured with stainless steel bolts. The assembly shall include two resilient seated isolation valves and four top mounted, resilient seated test cocks.

D. Furnish each backflow preventer with the following accessories and options:

1. OS & Y Gate Valves.
2. Ball Valve Test Cocks.
3. Approval for vertical up flow installation.

E. Provide minimum 18-inch clearance for servicing and testing.

F. The assembly shall meet the requirement of ASSE Std 1012 and AMCA Std C510.

G. Double check valve backflow preventers shall be Watts No. 709, Conbraco, Wilkens, Ancon, or approved equal.

2.11. TRAP PRIMING STATION-AUTOMATIC TRAP PRIMER

A. Trap priming stations shall be Precision Plumbing Products, Inc., Electronic Trap Priming manifold Model PT. The manifold shall supply a minimum of 2 ounces of potable water per opening at 20 PSIG once in each 24 hour period. The Electronic Trap Priming Manifold must be capable of equally priming from 4 through 30 individual floor drain traps.

B. The unit shall be factory assembled and prepiped, and shall include a bronze body 3/4-inch

female NPT WOG rated ball valve 3/4-inch, Water Hammer Arrestor, copper barrel with brass piston and type "L" copper sweat connection, electronic brass body 3/4-inch solenoid valve, and type "L" copper manifold with brass 2-inch compression fitting and orifice opening for precision water distribution to each floor drain trap. Unit shall be pre-piped with atmospheric vacuum breaker.

C. Electronic components shall include single point power connection at 120 volt 1 phase 60 hertz, manual over-ride switch, minimum 5 amp breaker, 24 hour geared timer with relay and 5 second dwell function.

D. All components shall be factory assembled, tested and supplied in a 16 gauge steel enclosure suitable for surface or recess mounting, as indicated on contract drawings. In addition, all components must comply with nationally recognized standards. The Precision Plumbing Products Electronic Trap Priming Manifold shall be fully warranted for the life of the plumbing system.

E. When only a single trap primer is required, as in the case of a restroom with one floor drain in a toilet (or similar) the contractor may submit, in lieu of an electronic multiple station, a single station for review by the Engineer. The fixture serving the trap primer must be within 10' of the trap. Components shall be brass, bronze, and chrome, of the highest quality.

F. Access door shall be finished with a prime coat and fire rated where installed in a rated wall. Access door latch shall be Allen key type.

2.12. DOMESTIC WATER METER WITH ATC INTERLOCK CAPABILITIES

A. Furnish and install a bronze magnetic drive flanged turbo-water meter on incoming water service to building and where indicated. The water meter shall be Model WPX-211 as manufactured by Niagara, Rockwell, Hersey, or approved equal. Unit shall be sized and selected so as not to exceed the scheduled maximum pressure drop at design flow.

B. Main cases for all sizes shall be cast Water Works bronze. Size, model and direction of flow shall be cast, in raised characters, on both sides of the Main cases.

Operating Characteristics		
Meter Size	Low Flow (95percent minimum)	Normal Range (100.0 +/- 1.5 percent)
2-inch	3	4 to 160
3-inch	4	5 to 350
4-inch	10	15 to 1000
6-inch	20	30 to 2000
10-inch	55	55 to 5500

1. 8-inch and 12-inch pipeline size applications can be accomplished by using the 6-inchand 10-inch size meters respectively with the appropriate tapered, concentric reducers.

C. Meters shall have performance capabilities of continuous operation up to the rated maximum

flows as outlined above without affecting long term meter accuracy or causing undue wear. Meters shall also have a 25 percent flow capacity in excess of the maximum flows listed for intermittent flow demands.

D. The measuring chamber shall be of unitized construction (i.e., complete with measuring element, calibration device and register in one assembly). The measuring chamber shall be capable of operating within above listed accuracy limits without recalibration when transferred from one main case to another. The measuring element shall be mounted on a horizontal stationary shaft with sleeve bearings and be essentially weightless in water.

E. The register shall be permanently hermetically sealed; all registers of similar size and registration to have a standard ratio gear reduction so as to permit interchange ability. The register shall be assembled to measuring chamber in a tamper proof manner so removal can be made only after measuring chamber is removed from the maincase. Sweep hand reading and odometer wheel details will conform to American Water Works Standard C-701, as most recently revised.

F. All reduction gearing shall be enclosed in the permanently hermetically sealed register. The drive magnet shall be located in the measuring element, and the follower magnet shall be located inside the permanently hermetically sealed register. An intermediate magnetically active material shall be required to distribute the magnetic flux uniformly to the follower magnet, thereby improving the service life of the register's rotating components.

G. All meters shall operate without leakage, damage or malfunction up to a maximum operating pressure of 150 pounds per square inch.

H. The 6-inch and 10-inch size meters shall have external strainers as part of the meter package. Strainers shall have cover plate for inspection and removal of debris from the bronze screen without disturbing the pipeline.

I. Flanges on 2-inch size meters shall be oval faced and drilled on the horizontal axis with a bolt circle diameter of 4 ½ -inch. Thickness shall be as required for Class 125 round flanges. Flanges for 3-inch, 4-inch, 6-inch and 10-inch size meters shall be of the Class 125 round type, flat faced, and shall conform to ANSI 16.1 for specified diameter, drilling and thickness. Companion flanges, if required with the meters, shall consist of one standard cast iron flange, tapped with American Standard internal taper pipe threads, and one flanged coupling adapter. The type and outside diameter of connecting pipe shall be provided for appropriate gasket sizing. All bolts, nuts and gaskets shall be provided.

J. Turbine meters of similar design concept must be available for purchase in all of the sizes specified above. The turbine meters must have a minimum of five (5) years of satisfactory operating experience as marketable products. Limited experimental history is not acceptable. The meter manufacturer shall submit, in writing, a price schedule of its factory maintenance program for the measuring chambers.

K. The water meter shall be fully field insulated and jacketed to prevent condensation.

L. The water meter shall be provided with a high frequency pulse output device for interface with Automatic Temperature Control System. The Infrared Pulser shall be Model 860 as manufactured by Hersey or approved equal.

M. A Pulse to DC converter shall be supplied with the Infrared Pulser. The device shall convert pulses from a variety of liquid flow sensing devices to a 4-20mA output signal which is proportional to the flow rate. This output shall transmit flow rate data over long distances with no loss of accuracy. The converter shall be Model 1005 as manufactured by Hersey or approved equal.

N. At contractor's option a water meter provided by the ATC subcontractor may be utilized.

2.13. DOMESTIC WATER EXPANSION TANKS

A. Provide and install domestic water expansion tanks of size, capacity and as indicated on contract drawings. Domestic water expansion tanks shall be Therm-X-TROL as manufactured by AMTROL Inc., Flexcon, Wessels, Taco, Armstrong, or approved equal. Mount tank as detailed on the drawings.

B. Domestic water expansion tanks shall be specifically designed for use in potable water systems. Tanks shall be pre-charged to require pressure at the factory. The maximum working pressure shall be 150 psig. The maximum operating temperature shall be 200 degrees F. Expansion tanks shall contain removable FDA approved butyl bladder.

C. Before installation, Contractor shall adjust the tank air pre-charge pressures to equal city water pressure.

D. The tank must be constructed in accordance with Section VIII of the A.S.M.E. boiler and pressure vessel code and stamped 150 psig working pressure.

E. Accessories: Pressure gauge and air charging fitting, tank drain, pre-charge as indicated on contract drawings and factory installed clip angles.

2.14. INTERIOR RECESSED WALL HYDRANTS

A. Provide and install recessed wall hydrants where indicated on the contract drawings. Recessed wall hydrants shall be Zurn Model Z 1330, Josam, Ancon, Mifab, Watts or approved equal.

B. Units shall be encased Ecotrol “anti-siphon" wall hydrant for interior wall installation.

C. Each unit shall be complete with integral backflow preventer, all bronze interior parts, non-turning operating coupling with hemispherical neoprene plunger and 3/4-inch solder inlet.

D. Furnish each unit mounted in a stainless steel box and hinged cover with operating key lock and "water" stamped on cover.

E. Furnish each unit with the following accessories:
1. 3/4 inch – 90 degrees inlet elbow with union nut
2. cylinder lock
3. key operator

2.15. ICE MAKER COLD WATER INLET FILTER

A. Provide and install a cartridge type water filter on the cold water inlet to the ice maker as detailed on the contract drawings. Housing shall be constructed of PVC with 3/4-inch NPT connections. Heads shall be cast bronze nickel plated with nickel plated "T" handle cap nut. Unit shall have pet cock bottom drain. Housing shall contain two (2) 20 micron cartridge filters. The entire filter assembly shall be rated for 150 psig. Unit shall be capable of handling a minimum 6 gpm. Housing shall be as manufactured by Keystone or approved equal.

B. Install filter housing to allow access for service and filter replacement.

PART 3. EXECUTION

3.01. GENERAL INSTALLATION REQUIREMENTS

A. Install all equipment in accordance with manufacturer's instructions.

B. Install components plumb and level.

C. Cleanouts in vertical pipes shall be installed in tees near floor. Cleanouts in horizontal pipes shall be installed with wyes on long sweep quarter beds. Cleanouts punching water proofing membranes shall have flashing clamps. Cleanout access covers in dry wall or gypsum board shall be painted to match walls.

D. Unless otherwise noted, drains are to be installed at the low point of floors. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

E. Install floor drains in low points so the top of grates are at or below the finished floor level.

F. Drains not functioning properly shall be removed and re-installed properly at the expense of the contractor.

G. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

H. Extend cleanouts to finish floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

I. Encase exterior cleanouts in concrete flush with grade.

J. Coordinate with plumbing piping and related electrical work to achieve a complete operating system.

K. Install domestic water storage tanks in accordance with manufacturer's instructions.

L. Provide painted steel pipe support for tanks independent of building structural framing members.

M. Clean and flush domestic water storage tanks after installation. Seal until pipe connections are made.

N. All plumbing, vents in exterior walls shall be offset a minimum of 3'-0" in ceiling at roof before penetration.

O. All plumbing vents within a 10'-0" radius of exhaust vents shall be extended to a height of 3'-0" above exhaust vent crown.

P. All plumbing vents within a 10'-0" radius of any rooftop unit or intake louver shall be extended to a height of 3'-0" above fresh air intake.

Q. Slopes and invert elevations of all interior piping shall be established before any piping is installed in order that proper slopes will be maintained. All piping shall be located and determined where to be run to avoid conflict with other trades.

R. Unless otherwise noted, all plumbing piping shall be routed as high as possible between bottom of roof joists and above ceiling to allow proper installation of ductwork, fire protection piping, conduits, etc.

S. Coordinate with Architectural Drawings before roughing in plumbing.

T. All openings in ceilings and plenum walls for plumbing shall be sealed air tight and protected with fire stop.

U. See site plan for extent of all piping leaving and entering building.

V. See domestic water riser diagrams for location of valves, shock absorbers, etc.

W. Make proper HW, CW, re-cir., waste, and vent connections to all equipment even though all branch main, elbows and connections are not shown.

X. Cleanouts shall be provided near base of each vertical waste or solid stack. Provide 18" minimum clearance for access.

Y. Unless otherwise noted, sanitary waste piping shown is below floor and all other piping is overhead, above ceiling. Domestic hot, cold and re-circ. water piping shall be installed between ceiling and roof insulation.

Z. Unless otherwise noted, horizontal sanitary piping pitches shall be 1 percent.

AA. Unless otherwise noted, all domestic water piping shall be installed on heated side of ceiling insulation.

BB. All piping and installation shall comply with all local and national plumbing codes. Test piping as required by plumbing code and authority having jurisdiction.

CC. For sizes of all domestic water piping see plumbing fixture schedule and domestic water riser diagrams.

DD. For sizes of all sanitary and vent piping see plumbing fixture schedule and sanitary/vent riser diagrams.

3.02. DOMESTIC WATER HEATER INSTALLATION REQUIREMENTS

A. Install units on concrete bases, level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Anchor units to substrate.

C. Install temperature and pressure relief valves in top portion of storage tank shells of units with storage. Use relief valves with sensing elements that extend into shells. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain. Install union on relief valve discharge piping. Install automatic air vent at top of hot water supply piping with union ball valve.

D. Install pressure relief valves in water piping for units without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.

F. Install unit drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section, *Plumbing Piping, Fittings and Valves* for drain valves.

G. Install thermometers on unit inlet and outlet piping. Refer to Division 22 Section, *Plumbing Piping, Fitting and Valves* for thermometers. Install pressure gages on unit piping.

I. Fill unit with water. Install domestic water expansion tank and charge with air .Install piping adjacent to units to allow service and maintenance.

L. Connect hot- and cold-water piping with shutoff valves and unions. Connect hot-water-circulating piping with shutoff valve, check valve, and union.

M. Make connections with dielectric fittings where piping is made of dissimilar metal.

N. Electrical Connections: Power wiring is specified in Division 26 Sections. Arrange wiring to allow unit servicing.

O. Ground equipment

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.Engage a factory-authorized service representative to perform startup service.

Q. In addition to manufacturer's written installation and startup checks, perform the following:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment and retest until satisfactory results are achieved.

2. Verify that piping system tests are complete.
3. Check for piping connection leaks.
4. Check for clear relief valve inlets, outlets, and drain piping .Check operation of circulators.
6. Test operation of safety controls, relief valves, and devices. Energize electric circuits.
8. Adjust operating controls.
9. Adjust hot-water-outlet temperature settings. Do not set above 120 deg F unless piping system application requires higher temperature.

3.03. PLUMBING SPECIALTY INSTALLATION REQUIREMENTS

A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.

B. Install backflow preventers of type, size, and capacity indicated, at each water-supply connection to mechanical equipment and systems, and to other equipment and water systems as indicated. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment. Install air-gap fitting on units with atmospheric-vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer.

C. Field test all backflow preventers and submit test reports to Engineer. Furnish test kits as required for field testing.

D. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.

E. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve, and where indicated.

F. Install hose bibbs with integral or field-installed vacuum breaker.

G. Install wall hydrants with integral or field-installed vacuum breaker.

H. All hose bibs shall be mounted 18" above finished floor, unless otherwise specified.

I. All wall hydrants shall be mounted 24" above finished grade unless otherwise specified.

J. Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of one percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow. Install trap priming stations plumb and level with adequate access for servicing and maintenance.

L. Install backwater valves in building drain piping as indicated. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated. For exterior installation provide handhole with hinged cover and top mounted to be flush with grade.

N. Fasten recessed, wall-mounting plumbing specialties to reinforcement built into walls.

O. Secure supplies to supports or substrate.

P. Install individual stop valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve as appropriate is not indicated.

Q. Install water-supply stop valves in accessible locations.

R. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

S. Include wood-blocking reinforcement for recessed and wall-mounting plumbing specialties.

T. Install ball valves at all shock absorbers to allow removal for service/replacement.

3.04. WATER METER INSTALLATION REQUIREMENTS

A. Install water meters, piping, and specialties according to Manufacturer's requirements.

1. Install displacement-type water meters with shutoff valve on water meter inlet. Install valve on water meter outlet and valved bypass around meter, unless prohibited by authorities having jurisdiction.

2. Install compound-type water meters with shutoff valves on water meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.

B. Install power and control wiring from water meter to ATC system.

C. Field insulate and jacket water meter to prevent condensation.

3.05. FITTINGS FOR FIXTURES SUPPLIED BY OTHERS

A. Fixtures such as kitchen equipment are provided under other divisions of the specifications and are complete with strainer and tailpiece. Fittings, accessories and connection of these fixtures to the plumbing system are provided under this section.

B. Rough-in and final connection includes but is not limited to all domestic water, waste, and vent systems. Furnish stops, strainers, vacuum breakers, and under counter insulation where not furnished under another Division of these specifications.

3.06. TESTING

A. After plumbing fixtures are connected, all piping and fixtures shall be tested for operation and a smoke or peppermint test shall be made on all soil, waste and vent piping.

B. After the building has been occupied and the various equipment is in actual use, the

Contractor shall make an operating test of all equipment at a time directed by the Engineer to determine that all contract requirements are met.

3.07. CLEANING AND STERILIZATION

A. After final testing for leaks, all potable water lines shall be thoroughly flushed, by plumbing contractor, to remove foreign material. Before placing the systems in service, sterilize the new water lines in accordance with local health department codes and at a minimum according to the following procedure:

1. Through a 3/4-inch hose connection in each branch main and building main, pump in sufficient sodium hypochlorite to produce a free available chlorine residual of not less than 200 ppm. Plumbing Contractor shall provide plumbing connections and power for pumping chlorine into system.

2. Proceed upstream from the point of chlorine application opening all faucets and taps until chlorine is detected. Close faucets and taps when chlorine is evident.

3. When chlorinated water has been brought to every faucet and tap with a minimum concentration of 200 ppm chlorine, retain this water in the system for at least three (3) hours.

4. CAUTION: Over-concentration of chlorine and more than three (3) hours of retention may result in damage to piping system. It is not necessary to retain chlorine in any system for twenty-four hours to achieve sterilization. AWWA states that 200 ppm chlorine for three hours is sufficient.

5. At the end of the retention period, no less than 100 ppm of chlorine shall be present at the extreme end of the system.

6. Proceed to open all faucets and taps and thoroughly flush all new lines until the chlorine residual in the water is less than 1.0 ppm.

7. Obtain representative water sample from the system for analysis by an independent and recognized bacteriological laboratory.

8. If the sample tested for coliform organisms is negative, a letter and laboratory report shall be submitted by the service organization to the Contractor, certifying successful completion of the sterilization. Additionally, this report shall be forwarded to the Owner as well as be included in the O&M Manual.

9. If any samples tested indicate the presence of coliform organisms, the entire sterilization procedure shall be repeated.

10. Take precautions to avoid use of plumbing fixtures and domestic water systems during sterilization period. Place signs on all plumbing fixtures and outlets during sterilization period.

3.08. EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

3.09. PREPARATION

A. Confirm rough-in location and size of fixtures and openings prior to commencing work.

B. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.10. INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.11. CLEANING

A. At completion, clean plumbing equipment.

END OF SECTION

DIVISION 23 SECTION 230500
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SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1. GENERAL

1.01. SUMMARY

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

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all mechanical work.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.

D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, ductwork, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.

E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

F. Coordinate the work under Division 23 with the work of all other construction trades.

G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

1.02. PERMITS AND FEES

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

B. Permits and fees shall comply with the Division 01, *General Requirements* of the specification.

1.03. EXAMINATION OF SITE

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

B. Examine and verify specific conditions described in individual specifications sections.

C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.04. CONTRACTOR QUALIFICATION

A. Any Contractor or Subcontractor performing work under Division 23 shall be fully qualified and acceptable to the Architect/Engineer and Owner. Submit the following evidence when requested:

1. A list of not less than five comparable projects which the Contractor completed.

2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.

3. Local and/or State License, where required.

4. Membership in trade or professional organizations where required.

B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.

C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.05. MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

D. Substitution will not be permitted for specified items of material or equipment where noted.

E. All items of equipment furnished shall have a service record of at least five (5) years.

1.06. FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.07. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

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

B.	AABC	-	Associated Air Balance Council
C.	ADC	-	Air Diffusion Council
D.	AMCA	-	Air Movement and Control Association
E.	ANSI	-	American National Standards Institute
F.	ASHRAE	-	American Society of Heating, Refrigerating and Air Conditioning Engineers
G.	ASME	-	American Society of Mechanical Engineers
H.	ASPE	-	American Society of Plumbing Engineers
I.	ASTM	-	American Society for Testing and Materials
J.	DNREC	-	Delaware Department of Natural Resources
K.	IBC	-	International Building Code
L.	IEEE	-	Institute of Electrical and Electronics Engineers
M.	MSSP	-	Manufacturers Standards Society of the Valve and Fittings Industry
N.	NEC	-	National Electrical Code
O.	NEMA	-	National Electrical Manufacturers Association
P.	NFPA	-	National Fire Protection Association
Q.	SMACNA	-	Sheet Metal and Air Conditioning Contractors National Association
R.	UL	-	Underwriters' Laboratories

S. All mechanical equipment and materials shall comply with the codes and standards listed in the latest edition of ASHRAE HVAC Applications Handbook, Chapter entitled *Codes and Standards*.

1.08. SHOP DRAWINGS

A. Prepare and submit shop drawings for all mechanical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.

B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.

C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

D. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

E. Items and Systems

Access Doors/Panels including layouts and locations
Air Distribution Systems
Automatic Temperature Control Systems and Equipment
Coordinated Drawings
Duct Materials
Electric Unit Heaters
Fans
Filters
Fire Stopping - Methods and Materials
Grilles, Registers, Diffusers
Identification Systems
Material and Equipment Lists
Operations and Maintenance Manuals
Pipe Materials Including Itemized Schedules
Preliminary Testing and Balancing Reports
Test Certificates
Thermal Insulation Materials Include Table Summaries
Vibration Isolation Materials
Wiring Diagrams, Flow Diagrams and Operating Instructions

F. Contractor, additionally, shall submit for review any other shop drawings as required by the Architect and/or Engineer. No item shall be delivered to the site, or installed, until the Contractor has received a submittal from the Engineer marked *Reviewed* or *Comments Noted*. After the proposed materials have been reviewed, no substitution will be permitted except where approved by the Architect and/or Engineer.

G. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

1.09. CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division

23. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect or Engineer.

1.10. PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where pipes penetrate roofs, flash pipe with Stoneman *Stormtite*, Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.

C. Furnish and install pitch pockets or weather tight curb assemblies where required.

D. Furnish and install roof drains, curbs, vent assemblies, and duct sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer’s instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

1.11. DRIVE GUARDS

A. Provide safety guards on all exposed belt drives, motor couplings, and other rotating machinery. Provide fully enclosed guards where machinery is exposed from more than one direction.

B. When available, guards shall be factory fabricated and furnished with the equipment. Otherwise fabricate guards of heavy gauge steel, rigidly braced, removable, and finish to match equipment served. Provide openings for tachometers. Guards shall meet local, State and O.S.H.A. requirements.

1.12. VIBRATION ISOLATION

A. Furnish and install vibration isolators, flexible connections, supports, anchors and/or foundations required to prevent transmission of vibration from equipment, piping or ductwork to building structure. See Division 23 Section, *Vibration Control for HVAC, Plumbing and Fire Protection Equipment.*

1.13. FASTENERS/CAPS

A. All fasteners located in public spaces including locker rooms, corridors, lobbies, toilet rooms, etc., shall be provided with tamper proof fasteners. Provide Pin Phillips hardware as manufactured by Challenge Industries or approved equal.

1.14. DEFINITIONS

A. *Approve* - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.

B. *Furnish and install* or *provide* means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

C. *Contractor* means the mechanical contractor and any of his subcontractors, vendors, suppliers, or fabricators.

D. *Piping* includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.

E. *Ductwork* includes duct material, fittings, hangers, insulation, sealant, identification and other accessories

F. *Concealed* means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or in crawl space or attic.

G. *Exposed* means not installed underground or *concealed* as defined above.

H. *Invert Elevation* means the elevation of the inside bottom of pipe.

I. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.

J. *Review* - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

K. *Building Line:* Exterior wall of building.

1.15. MINIMUM EFFICIENCY REQUIREMENTS

A. All heating, ventilating, and air conditioning equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

B. All piping, ductwork, and equipment insulation shall comply with ASHRAE Standard 90.1, latest edition.

C. All service water/heating equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

D. All mechanical devices, controls, accessories, and components shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

1.16. SYSTEM INTEGRATION

A. For all HVAC equipment specified to be provided with packaged controls and interfaced with the automatic temperature control system, provide system integration between the equipment manufacturer and the automatic temperature control subcontractor.

B. HVAC equipment submittals requiring system integration as defined above must identify all required system integration points.

C. HVAC equipment manufacturers must coordinate with ATC subcontractor regarding system integration prior to submitting on the equipment.

D. A system integration meeting must be arranged by the Mechanical Contractor and include, but not be limited to the systems integrator for the HVAC equipment manufacturer and the ATC Subcontractor. This portion of systems integration must occur prior to HVAC equipment being delivered to the project.

E. Once the HVAC equipment is on site, a second systems integration meeting must be arranged by the Mechanical Contractor to coordinate the packaged controls with the ATC system. The HVAC equipment manufacturer's representative familiar with system integration and the ATC subcontractor familiar with programming must be present.

F. A final system integrations meeting shall occur once all equipment is in place and ready for operation. The Mechanical Contractor, the HVAC equipment systems' integrator, and the ATC Subcontractor shall meet on site to jointly program, schedule, verify points, interlock devices, and fully set up all systems integration components.

G. All systems integration coordination, programming, and graphics must be completed prior to requesting commissioning and/or inspections by the Engineer of Record.

1.17. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

1.18. LEED SUBMITTALS

A. Product data for Credit EQ 4.1: For adhesives, welding solvents, and sealants applied within the building water proofing envelope, documentation including printed statement of VOC content in g/L.

B. Product data for Credit EQ 4.2: For paints, mastics, and coatings applied within the building water proofing envelope, documentation including printed statement of VOC content in g/L.

C. Product data for Credit EQ 4.4: For plywood backboards installed within the building water proofing envelope, documentation indicating no added urea formaldehyde resins.

D. Product data for Credit EQ 3: For filter media installed during construction and prior to occupancy, documentation indicating MERV rating.

PART 2. ELECTRICAL REQUIREMENTS

2.01. GENERAL MOTOR AND ELECTRICAL REQUIREMENTS

A. Furnish and install control and interlock wiring for the equipment furnished. In general, power wiring and motor starting equipment will be provided under Division 26. Carefully review the contract documents to coordinate the electrical work under Division 23 with the work under Division 26. Where the electrical requirements of the equipment furnished differ from the provisions made under Division 26, make the necessary allowances under Division 23. Where no electrical provisions are made under Division 26, include all necessary electrical work under Division 23.

B. All electrical work performed under Division 23 shall conform to the applicable requirements of Division 26 and conforming to the National Electric Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA & BOCA.

C. Provide wiring diagrams with electrical characteristics and connection requirements.

D. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than five (5) horsepower.

E. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.

F. All motors shall be furnished with visible nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer’s name and model number, service factor, power factor and efficiency.

G. Motors located in exterior locations, wet air streams, air cooled condensers, and outdoors shall be totally enclosed weatherproof epoxy-treated type.

H. Nominal efficiency and power factor shall be as scheduled at full load and rated voltage when tested in accordance with IEEE 112.

I. Brake horsepower load requirement at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.0 and 1.15 service factors.

J. All single phase motors shall be provided with thermal protection: Internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature ratings of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

2.02. MOTORS AND CONTROLS

A. Motors and controls shall conform to the latest requirements of IEEE, NEMA, NFPA-70 and shall be UL listed. Motor sizes are specified with the driven equipment. Motor starting and control equipment is specified either with the motor which is controlled or in an electrical specification section. The Contractor is advised to consult all specification sections to determine responsibility for motors and controls.

B. Motors shall be designed, built and tested in accordance with the latest revision of NEMA Standard MG l.

C. Motors shall be suitable for use under the conditions and with the equipment to which applied, and designed for operation on the electrical systems specified or indicated.

1. Motor capacities shall be such that the horsepower rating and the rated full-load current will not be exceeded while operating under the specified operating conditions. Under no condition shall the motor current exceed that indicated on the nameplates.

2. Motor sizes noted in the individual equipment specifications are minimum requirements only. It is the responsibility of the equipment manufacturers and of the Contractor to furnish motors, electrical circuits and equipment of ample capacity to operate the equipment without overloading, exceeding the rated full-load current, or overheating at full-load capacity under the most severe operating service of this equipment. Motors shall have sufficient torque to accelerate the total WR^2 of the driven equipment to operating speed.

3. Motors shall be continuous duty type and shall operate quietly at all speeds and loads.

4. Motors shall be designed for operation on 60 hertz power service. Unless otherwise specified or shown, motors less than ½ horsepower shall be single phase, and motors ½ horsepower and larger shall be 3 phase unless otherwise noted.

5. Motors shall be mounted so that the motor can be removed without removing the entire driven unit.

D. Single phase motors, smaller than 1/20 horsepower shall be ball or sleeve bearing; drip-proof, totally enclosed or explosion proof, as specified; 120 volts; permanent-split capacitor or shaded pole type. These motors shall not be used for general power purposes, and shall only be provided as built-in components of such mechanical equipment as fans, unit heaters, and damper controllers. When approved by the Engineer, deviations from the specifications will be permitted as follows:

1. Open motors may be installed as part of an assembly where enclosure within a cabinet provides protection against moisture.

2. Motors used in conjunction with low voltage control systems may have a voltage rating less than 115 volts.

E. Single phase motors, greater than 1/20 horsepower and less than ½ horsepower shall be ball bearing; drip-proof, totally enclosed or explosion proof, as specified, with Class A or B insulation, as standard with the motor manufacturer; 115 or 120/208/240 volts as required; capacitor start-induction run, permanent split capacitor, or repulsion start-induction run type with minimum efficiency of 70 percent and a minimum full load power of 77 percent.

F. Except as otherwise specified in the various specification sections, 3 phase motors 60 horsepower and smaller shall be NEMA design B squirrel cage induction type meeting the requirements of this paragraph. Motors shall be drip-proof, totally enclosed or explosion proof, as specified or indicated. Insulation shall be Class B or F, at 40 degrees C ambient temperature. Drip-proof motors shall have a 1.15 service factor and totally enclosed and explosion proof motors shall have a service factor of 1.00 or higher. Motors specified for operation at 480, 240, and 208 volts shall be nameplated 460, 230, 200 volts, respectively. Efficiencies and percent power factor at full load for three phase motors shall be not less than the values listed below for premium efficiency motors:

MOTOR NAMEPLATE	MINIMUM PERCENT EFFICIENCY AT NOMINAL SPEED AND RATED LOAD	MINIMUM PERCENT POWER FACTOR
1HP and above to	85.5 percent	84 percent
1-½ HP	86.5 percent	85 percent
2HP	86.5 percent	85 percent
3HP	89.5 percent	86 percent

G. Three phase motors ½ HP or greater shall be the Duty Master XE by Reliance Electric Company, Super-E Premium Efficiency of Baldor Motor and Drives, E-plus Efficient Standard Duty Motor of the Electric Motor Division of Gould, Inc., the MAC II High Efficiency motor of Westinghouse Electric Corp., the equivalent product of General Electric, or approved equal.

H. For motors serving equipment being controlled by a variable speed drive, motor shall be premium efficiency inverter duty rated.

I. Motor frames shall be NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast-iron or aluminum with steel inserts.

J. Control of each motor shall be manual or automatic as specified for each in the various mechanical sections. In general, and unless otherwise specified for a particular item in the various mechanical sections of the specifications, motor starters and controls shall be specified and provided under the various electrical sections of these specifications.

2.03. MOTOR INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Install securely on firm foundation. Mount ball bearing motors to support shaft regardless of shaft position.

C. Check line voltage and phase and ensure agreement with nameplate. Check that proper thermal overloads have been installed prior to operating motors.

2.04. WIRING DIAGRAMS

A. The Contractor is responsible for obtaining and submitting wiring diagrams for all major items of equipment.

B. Wiring diagrams shall be provided with shop drawings for all equipment requiring electric power.

C. Provide wiring diagrams for all major mechanical items of equipment to electrical contractor and ATC subcontractor for coordination.

PART 3. EXECUTION

3.01. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to Architect and/or Engineer.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment giving right of way to piping installed at required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.02. SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For un-insulated copper piping provide copper hanger to prevent contact of dissimilar metals. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

3.03. PROVISIONS FOR ACCESS

A. The contractor shall provide access panels and doors for all concealed equipment, valves, dampers, filters, controls, control devices, cleanouts, fire dampers, damper operators, traps, and other devices requiring maintenance, service, adjustment, balancing or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Mark each access door within finished spaces with a small color coded and numbered tab. Provide a chart or index for identification. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, and lighting to provide a neat and symmetrical appearance.

3.04. PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 23 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed ductwork, piping, equipment, etc. shall be painted. Colors shall be as stated

in this division or as selected by the Architect and/or Owner and conform to ANSI Standards.

H. All exterior roof mounted ductwork, equipment, piping, breeching, and vents shall be painted to match roof in color as selected by Architect and/or Owner.

I. All exposed ductwork, piping, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

J. All exposed ductwork, piping, equipment, etc., in mechanical rooms, utility rooms, janitor's closets, and storage where PVC jacketed shall not require painting. Label and identify and color code as specified.

3.05. CLEANING OF SYSTEMS

A. Clean fans, ductwork, enclosures, flues, registers, grilles, and diffusers at completion of work.

B. Install filters of equal efficiency to those specified in permanent air systems operated for temporary heating during construction. Replace with clean filters as specified prior to acceptance and after cleaning of system.

C. Pay for labor and materials required to locate and remove obstructions from systems that are clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.

D. Leave systems clean, and in complete running order.

3.06. COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

B. Submit color of factory-finished equipment for acceptance prior to ordering.

3.07. PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in piping, ductwork, and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.08. OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, balancing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing and balancing work. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

D. Do not use mechanical systems for temporary services or temporary conditioning during construction, unless approved by Owner in writing. Refer to Division 01 Section *"Temporary Facilities and Controls"* for temporary heating/cooling during construction.

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters.

3.09. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a videographer to record demonstration and training video recordings. Record each training module separately.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Engineer

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.10. IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS

A. Contractor shall submit for approval schematic piping diagrams of each piping system installed in the building. Diagrams shall indicate the location and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under safety glass and hung in each Mechanical Room where directed. Contractor shall deliver the tracing or sepia from which the

diagrams were reproduced to the Owner.

B. All valves shall be plainly tagged. For any bypass valves, install sign indicating valve position as “Normally Open” or “Normally Closed” as required.

C. All items of equipment, including motor starters, disconnects and ATC panels shall be furnished with white on black plastic permanent identification cards. Lettering shall be a minimum of ¼ inch high. Identification plates shall be secured, affixed to each piece of equipment, starters, disconnects, panels by screw or adhesive (tuff bond #TB2 or as approved equal).

D. Provide three (3) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the *Record and Information Booklet* as hereinafter specified.

E. All lines piping and ductwork installed under this contract shall be stenciled with *direction of flow* arrows and with stenciled letters naming each pipe and ductwork and service. Refer to Division 23 Section, *HVAC Piping, Fittings, Valves, Etc.* and Division 23 Section, *HVAC Air Distribution*. Color-code all direction of flow arrows and labels. In finished spaces omit labeling and direction of flow arrows. Paint in color as selected by Architect.

F. Submit list of wording, symbols, letter size, and color coding for mechanical identification. Submit samples of equipment identification cards, piping labels, ductwork labels, and valve tags to Engineer for review prior to installation.

G. Provide at least 8 hours of straight time instruction to the operating personnel. Time of instruction shall be designated by the Owner. Additional instruction time for the automatic temperature control (ATC) system is specified in Division 23 Section, *Instrumentation & Controls of HVAC & Plumbing Systems.*

H. Contractor shall demonstrate Sequences of Operation of all equipment in presence of Owner’s representative, Commissioning Authority (CxA), and ATC subcontractor.

3.11. WALL AND FLOOR PENETRATION

A. All penetrations of partitions, ceilings, roofs and floors by ducts, piping or conduit under Division 23 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 23 Section, *Vibration Control for HVAC, Plumbing and Fire Protection Equipment.*

B. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 07 Section, *HVAC & Plumbing Penetration Firestopping.*

C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.

D. Provide pipe escutcheons and duct flanges for sleeved pipes and ducts in finished areas.

E. Piping sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.

2. Twenty-two (22) gauge galvanized steel elsewhere.

F. Ductwork sleeves: 20 gauge galvanized steel.

3.12. RECORD DRAWINGS

A. Upon completion of the mechanical installations, the Contractor shall deliver to the Architect and/or Engineer one complete set of prints of the mechanical contract drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.13. WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the GENERAL CONDITIONS.

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer’s warranties shall be included in the operations and maintenance manuals.

C. The Contractor guarantees for a two year period from the time of final acceptance by the Owner.

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.

2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.

3. That the contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.

4. That the entire work shall be water-tight and leak-proof.

3.14. LUBRICATION

A. All bearings, motors, and all equipment requiring lubrication shall be provided with accessible fittings for same. Before turning over the equipment to the Owner, the

Contractor shall fully lubricate each item of equipment, shall provide one year's supply of lubricant for each, and shall provide Owner with complete written lubricating instructions, together with diagram locating the points requiring lubrication. Include this information in the Record and Information Booklet.

B. In general, all motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal accessible or extended grease fittings and drain plugs.

3.15. OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall have prepared six (6) copies of the Record and Information Booklet and deliver these copies of the booklet to the Owner. The booklet shall be as specified herein. The booklet must be approved and will not be accepted as final until so stamped.

B. The booklet shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manuals – Dover High School Outbuildings – Bid Pack G - HVAC.* No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the booklet:

1. As first entry, an approved letter indicating the starting/ending time of Contractor’s warranty period.
2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
3. Complete catalog data on each piece of heating and air conditioning equipment furnished including approved shop drawing.
4. Manufacturer's extended limited warranties on equipment including but not limited to air conditioning compressors, and heat pumps.
5. Chart form indicating frequency and type of routine maintenance for all mechanical equipment. The chart shall also indicate model number of equipment, location and service.
6. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
7. Provide supplier and subcontractor’s names, address, and phone number.
8. Catalog data of all equipment, valves, etc. shall include wiring diagrams, parts list and assembly drawing.
9. Provide and install in locations as directed by the Owner, valve charts including valve tag number, valve type, valve model number, valve manufacturer, style, service and location. Each valve chart shall be enclosed in a durable polymer based frame with a cover safety glass.
10. Copy of the approved balancing report including duct leakage data.
11. ATC systems including as-built ATC drawings of systems including internal of all panels.
12. Access panel charts with index illustrating the location and purpose of access panels.
13. Approved Health, and Electrical Certificates.
14. Start-up reports for equipment.
15. Provide and install in locations as directed by Owner, filter charts, including filter

type, size, model number, manufacturer, quantity and size for each filter utilized on the project. Filter charts shall be enclosed in a durable polymer based frame with a cover safety glass.

16. Insert color graphic with embedded parameters for ATC system into record and information booklet.
17. Filter charts indicating equipment served, size, and type of filter required.

D. Submit Record and Information Booklets prior to anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that Record and Information booklets be reviewed and approved.

3.16. INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following:

1. Complete Ductwork, Plumbing, and HVAC Piping Drawings showing coordination with lights, electrical equipment, HVAC equipment and structural amenities.

B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, piping and ductwork in areas involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.

D. Refer to Division 01 Section "*Project Management and Coordination*" for additional requirements related to coordination drawings.

3.17. EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections. Failure to do so will not relieve this contractor of any responsibility for improper equipment operation.

3.18. ADDITIONAL FILTERS

A. One complete set of additional filters shall be turned over to the owner upon final acceptance of the building by the owner. Provide correspondence to the Engineer (copy) documenting that additional filters have been turned over to Owner.

B. All filters shall be tagged and identified for equipment served. Furnish filters in

protection wrap.

END OF SECTION

DIVISION 23 SECTION 23 05 48
VIBRATION CONTROLS FOR HVAC, PLUMBING AND FIRE PROTECTION EQUIPMENT

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SECTION 23 05 48

VIBRATION CONTROLS FOR HVAC, PLUMBING AND FIRE PROTECTION EQUIPMENT

PART 1 RELATED DOCUMENTS

1.01 GENERAL

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 0I Specification Sections apply to work of this section.

B. All work under this section shall also be subject to the requirements of Division 23 Section, *Common Work Results for HVAC*.

1.02 SUMMARY

A. Provide all labor and materials necessary to furnish and install vibration control systems on this project as herein specified and/or shown on the drawings.

B. Mount all mechanical equipment on suitable vibration isolators so as to prevent transmission of vibration into or through the building structure. Isolators shall be as manufactured by Mason Industries, Inc., Korfund, Inc., Amber Booth, or approved equal, and shall be selected by the isolator manufacturer for each item of equipment in accordance with requirements hereinafter specified.

C. The equipment manufacturer shall supply all pump and motor bases, fan and motor bases, cradles, isolation pipe/duct hangers, spring and/or neoprene isolators, neoprene pads, flexible connectors, etc. as a coordinated package by a single manufacturer.

D. Select isolators for uniform static deflections according to distribution of weight; and for not less than the indicated isolation efficiency with the lowest rotational speed of equipment as the disturbing frequency.

E. Isolators and bases shall be stable during stopping and starting of equipment without transverse or eccentric movement of equipment, and shall be designed to resist horizontal forces of equipment which may operate unbalanced.

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

1.03 SUBMITTALS

A. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

B. Product Data: Provide schedule of vibration isolator type with location and load on each.

C. Manufacturer’s Installation Instructions: Indicate special procedures and setting dimensions.

D. Manufacturer’s Certificate: Certify that isolators are properly installed and adjusted to meet or

exceed specified requirements.

E. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

1.04 PROJECT RECORD DOCUMENTS

A. Record actual locations of hangers including attachment points.

1.05 COLOR CODING

A. All springs shall be color coded for load carrying capacity.

1.06 ALTERNATES

A. Refer to Division 01 Section, *Alternates* - Alternates for description of work under this section affected by alternates.

1.07 LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Isolators shall be the equivalent of the following types by Mason Industries, Inc., Korfund, Inc. or approved equal.

2.02 CORROSION PROTECTION FOR STEEL PARTS

A. Where steel parts are exposed to weather or humid environments provide hot-dipped galvanized coating of at least 2 ounces of zinc per square foot of surface. Coat springs with neoprene.

2.03 SUSPENSION ISOLATORS

A. General: Provide hangers with suspension isolators encased in open steel brackets. Isolate hanger rods from isolator steel brackets with neoprene-lined opening.

B. Suspension Neoprene Isolators: Provide double-deflection elements with minimum 3/8 inch

deflection.

C. Suspension Spring Isolators: Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing thru a 30° arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include a scale drawing of the hanger showing the 30° capability. Hangers shall be type 30N.

PART 3 EXECUTION

3.01 GENERAL PROVISIONS

A. Install vibration-and-noise isolation materials and equipment as indicated and in accordance with machinery manufacturer's instructions.

B. All vibration isolators exposed to weather or humid environment shall be hot dipped galvanized with springs coated with neoprene in accordance with paragraph hereinbefore described.

C. Anchor Bolts and Grout: Secure machinery to foundations and inertia bases with anchor bolts. Grout equipment with baseplates, the full area under baseplates with premixed non-shrinking grout. After grout has set, remove wedges, shims, and jack bolts and fill spaces with grout.

D. Common Machinery Foundations: Mount electrical motors on the same foundations as driven machinery. Support piping connections, strainers, valves, and risers on the same foundation as the pumps.

E. Lateral Motion: The installed vibration isolation systems for each piece of floor or ceiling mounted machinery shall have a maximum lateral motion under machinery start up and shut down conditions of not more than ¼ -inch. Restrain motions in excess by approved spring mountings.

F. Unbalanced Machinery: Provide foundation suspension systems specifically designed to resist horizontal forces for machinery with large unbalanced horizontal forces. Vibration isolator systems shall conform to the machinery manufacturer's recommendations.

G. Nonrotating Machinery: Mount nonrotating machinery in systems which includes rotating or vibrating machinery on isolators having the same deflection as the hangers and supports for the pipe connected to.

H. Unitized Machinery Assemblies: Unitized assemblies such as condensers, may be mounted on steel rails and springs in lieu of steel bases and springs. Where the slab or deck is less than 4 inches thick, provide spring isolation units with the deflection double that of the vibration isolation schedule, up to a maximum static deflection of 5 inches.

I. Vibration isolation ceiling hangers shall be installed so that the hanger rods do not touch the sides of the isolator housing, thereby seriously degrading the vibration isolation performance. Vibration isolation ceiling hangers shall be located so that the hanger housing may rotate 360° without touching any object.

J. Electrical Connections: Provide flexible conduit or multiple conductor cable connections for machinery with sufficient extra length to permit 2 inch minimum displacement in any direction without damage.

K. Systems Not To Be Vibration Isolated: Do not provide vibration isolation for electrical raceways and conduits or for fire protection, storm, sanitary, and domestic water piping systems which do not include pumps or other vibrating, rotating, or pulsating equipment including control and pressure reducing valves.

L. Install in accordance with manufacturer's instructions.

M. Install isolation for motor driven equipment.

N. Install spring hangers without binding.

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

P. 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.

Q. Connect wiring to isolated equipment with flexible hanging loop.

3.02 ISOLATION FOR SPECIFIC EQUIPMENT

A. The vibration isolator manufacture shall provide isolators for all pieces of equipment provided for the job. Isolator shall be selected by the isolator manufacturer on the basis of criteria as specified in the ASHRAE Applications Handbook, latest edition, unless a more stringent requirement is indicated on the drawings.

B. Fans:

1. Fans up to 22" wheel diameter shall be mounted stable steel springs in series with ribbed neoprene pads selected for not less than 1.5" static deflection (Mason Industries Type SLF or equivalent).

2. Fans with wheel diameters 24" and greater shall be mounted on unhoused stable steel springs in series with ribbed neoprene pads and structural rails selected for not less than 2.5" static deflection (Mason Industries Type SLF or equivalent and structural rails Type ICS with thrust restraint provisions) and rails shall be Type ICS.

3. All fans suspended from the ceiling, joists or roof structure, including exhaust fans, shall be suspended using hangers incorporating steel springs in series with neoprene, selected for not less than 1" static deflection under full load (Mason Industries Type 30N or equivalent).

C. All unit heaters shall be suspended using hangers incorporating steel springs in series with neoprene selected for not less than 1" static deflection under full load (Mason Industries Type 30N or equivalent).

END OF SECTION

DIVISION 23 SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC AND PLUMBING
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SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC AND PLUMBING

PART 1. GENERAL

1.01. GENERAL

A. This section covers performance testing, adjusting and balancing of heating, ventilating, air conditioning and domestic re-circulating systems as specified in Division 23 Section, *Heating, Ventilating, and Air Conditioning Equipment* and in Division 22 Section, *Plumbing Fixtures and Plumbing Equipment.*

B. For *Common Work Results of HVAC,* See Division 23. See Division 01 for *General Requirements*.

C. The mechanical contractor shall select and employ an impartial, independent balancing agency to provide testing and balancing services for the heating, ventilating and air conditioning (HVAC) systems and other specified systems of this project.

D. The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting and balancing the HVAC and plumbing systems, as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results.

E. The items requiring testing, adjusting, and balancing include, but are not limited to, the following:

Air Systems:
Coils (Air Temperatures & Static Pressure Drops)
Diffusers, Registers and Grilles
Electric Unit Heaters
Exhaust Fans
Zone Branch and Main Ducts

Hydronic Systems:
Domestic Hot Water Heater Pumps
Domestic Re-circulating Systems and Water Heater
Thermostatic Mixing Valves

1.02. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Section, including “Sustainable Design Requirements”, “Construction Waste Managements”, and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers, and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having

recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

1.03. EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a 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. Air coil fins are cleaned and combed.

8. Access doors are closed and duct end caps are in place.

9. Air outlets are installed and connected.

10. Duct system leakage is minimized.

11. Pumps are rotating correctly.

12. Proper strainer baskets are clean and in place.

13. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

C. Beginning of work means acceptance of exiting conditions.

1.04. QUALIFICATIONS OF THE BALANCE AGENCY

A. The balancing agency shall be a member of the Associated Air Balance Council (AABC) and have an engineer certified by the National Examining Board.

B. The certified test and balance engineer shall be responsible for supervision and certification for the total work herein specified.

C. All final reports shall be signed and officially stamped by the certified test and balance engineer.

1.05. PRE-BALANCING CONFERENCE

A. Convene a conference one week prior to commencing work of this Section with all appropriate individuals.

1.06. STANDARDS

A. The balancing agency shall perform the services specified herein in accordance with the Associated Air Balance Council's National Standards, including revisions, to the date of the contract.

B. All terms in this specification shall have their meaning defined as stated in the National Standards.

C. ADC: Test Code for grills, registers, and diffusers.

D. ASHRAE III: Practice for measurement, testing, adjusting and balancing of building heating, ventilation, air conditioning, and refrigeration systems.

E. NEBB: Procedure standards for testing, adjusting, and balancing of environmental systems.

F. SMACNA: HVAC systems testing, adjusting, and balancing.

G. AABC: Associated Air Balance Council

1.07. COORDINATION

A. It will be necessary for the balancing agency to perform its services in close coordination with the mechanical contractor.

B. The plans and specifications have indicated meters, valves, dampers, and other devices for the purpose of adjusting the system to obtain optimum operating conditions. It will be the responsibility of the mechanical contractor to install these devices in a manner that will leave them accessible and readily adjustable. The balancing agency shall provide guidance if there is a questionable arrangement of a control or balancing device.

C. The general contractor, mechanical contractor, temperature control contractor and suppliers of the HVAC equipment shall all cooperate with the balancing agency to provide all necessary data on the design and proper application of the system components.

1.08. INSTALLATION TOLERANCE

A. Unless otherwise indicated, all air devices shall be adjusted to within plus or minus 10 percent of design. All fans shall be adjusted to within plus or minus 5 percent of design. All pumps and Hydronic equipment shall be adjusted to within plus or minus 5 percent of design.

1.09. RESPONSIBILITIES OF THE MECHANICAL CONTRACTOR

A. The mechanical contractor shall sufficiently complete the installation and start all HVAC systems to insure they are working properly and shall perform all other items as described hereinafter to assist the balancing agency in performing the testing and balancing of the HVAC system.

B. Record equipment manufacturer's standard start-up information and submit to Engineer for review. Testing and balancing work shall not commence on any equipment until start-up reports have been completed, reviewed by Engineer, and forwarded to Testing and Balancing Agency.

C. Air Distribution Systems

1. Verify installation for conformity to design.

2. Terminate all supply, return, outside air, exhaust air, ventilation air ducts, and pressure test them for leakage. Test pressure and leakage rate shall be as specified in Division 23 Section, *HVAC Air Distribution System* under Leakage Tests. Pressure testing shall be performed by mechanical contractor and witnessed by Test and Balance Engineer.

3. Ensure that all volume dampers are properly located and functional. Dampers serving requirements of minimum and maximum outside - return - relief, and exhaust air shall provide tight closure and full opening, with a smooth and free operation.

4. Verify that all supply - return - exhaust and transfer grilles; registers, and diffusers are installed and operational.

5. Ensure that air-handling systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., are blanked and/or sealed to eliminate excessive bypass or leakage of air.

6. Ensure that all fans are operating and free of vibration. All fans and drives shall be checked for proper fan rotation and belt tension. Overload protection shall be of proper size and rating. A record of motor current and voltage shall be made to verify that the motors do not exceed nameplate rating. Record thermal overload ratings for all motors in the Test and Balance Report.

7. Install clean filters.

D. Water Circulating Systems

1. Verify installation for conformity to design.

2. Check all pumps to verify pump alignment and rotation.

3. Ensure that systems are clean, with the proper strainer screens installed for normal operation.

4. Check all pump motors for current and voltage, to ensure that motors do not exceed nameplate rating.

5. Provide thermal overload protection of proper size and rating. Record thermal overload ratings for all motors. Insert data in Test and Balance Report.

6. Ensure that all water circulating systems shall be full and free of air; that expansion tanks are set for proper water level; and that all air vents were installed at high points of systems and are operating.

1.10. RESPONSIBILITIES OF THE TEMPERATURE CONTROL CONTRACTOR

A. The temperature control contractor shall complete the installation of the temperature control system, and operate and test all control systems to ensure they are functioning properly as designed. The temperature control contractor shall assist the balancing agency in testing and balancing the HVAC systems, as described hereinafter.

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, freeze stats and duct smoke detectors.

2. Verify that all controlling instruments are calibrated and set for design operating conditions.

3. Calibrate temperature sensors after installation, and before the temperature sensors control verification tests are performed. The balancing agency shall prove the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditional space for each separately controlled zone.

4. The temperature control contractor shall allow sufficient time in the project to provide assistance and instruction to the balancing agency in the proper use and setting of control components such as, but not limited to, computers, static pressure controllers, or any other device that may need set points changed so that the testing and balancing work can be performed.

B. All control sequences, software, equipment, and components shall be started-up by a qualified technician. Start-up report shall be submitted to Engineer prior to the commencement of testing and balancing work. Testing and balancing shall not commence until start-up reports are completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

1.11. NOTIFICATION FOR TESTING AND BALANCING WORK TO BEGIN

A. The mechanical contractor shall notify the balancing agency in writing when all heating, ventilating, and air conditioning systems are complete and ready for testing and balancing. The mechanical contractor shall attest that he has completed all items as

herein described.

B. The following must be completed prior to start of system balancing:

1. All duct work and associated grilles/registers/diffusers installed and completed.

2. Piping systems completed, flushed and filled.

3. Equipment properly started by qualified personnel or start-up technicians.

4. Ceiling tiles installed.

5. Automation system (temperature controls) installed and completed for both air and water systems.

6. All equipment controlled in automatic (“Auto”) mode.

7. Access granted to the balancing contractor to the automation/controls system provided.

1.12. DEFICIENCIES

A. Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible person.

B. The work necessary to correct items on the deficiency listing shall be performed and verified by the affected Contractor before the TAB Agency returns to retest. Unresolved deficiencies shall be noted in the final report.

1.13. ADJUSTING

A. Ensure recorded data represents actual measured observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring all sensors to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

F. Check and adjust systems approximately six months after final acceptance and submit report.

G. Permanently mark the locations of all duct traverses on the outside duct insulation.

1.14. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

1.15. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

B. Submit air balance report for LEED Prerequisite IEQ1: Documentation of work performed for ASHRAE 62.1 Section 7.22- “Air Balancing”.

C. Submit report for LEED Prerequisite EA2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 “System Balancing”.

1.16. GENERAL COMMISSIONING REQUIREMENTS

A. Refer to Division 01 Section, “General Commissioning” for description of work under this Division affected by General Commissioning.

B. Submit air balance report for LEED Prerequisite IEQ1: Documentation of work performed for ASHRAE 62.1 Section 7.22, “Air Balancing”.

C. Submit report for LEED Prerequisite EA2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 “System Balancing”.

PART 2. PRODUCTS (NOT APPLICABLE)

PART 3. EXECUTION

3.01. GENERAL

A. Perform all testing and balancing in complete accordance with AABC National Standards for Field Measurements and Instrumentation.

B. Furnish all test instruments and equipment. All instruments must have been calibrated within six (6) months prior to use and shall be checked for accuracy prior to and during the work.

C. Review all systems designs and equipment, manufacturers’ data, and be completely familiar with the work before proceeding.

D. Report all malfunctions or deficiencies to the contractor so that corrective action can be taken. Test and Balance Report shall not be submitted for review until all malfunctions or deficiencies are corrected. Repeat tests where required until design conditions are achieved.

E. Where systems or equipment cannot be balanced or adjusted to design conditions, determine the cause and submit a complete report to the Engineer.

F. Retest or rebalance the system as required during the warranty period.

G. Test and balance all systems under adequate load condition. If, in the opinion of the Engineer, there is insufficient load to properly test and balance the systems, perform sufficient preliminary balancing and adjustment to permit operation of the systems until such time as final testing and balancing can be done. Provide in writing the future date when systems shall be tested under sufficient load.

H. At project completion provide a complete set of ½ scale drawings indicating the locations of all duct traverses.

3.02. EXAMINATION

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

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

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

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

E. Examine ceiling plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

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

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

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

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

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

J. Examine terminal units, and verify that they are accessible and their controls are connected and functioning.

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

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

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

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

3.03. AIR SYSTEM PROCEDURES

A. The balancing agency shall perform the following testing and balancing functions in accordance with the Associated Air Balance Council's National Standards:

1. Fan Speeds - Test and adjust fan RPM to achieve design CFM requirements.

2. Current and Voltage - Measure and record motor current and voltage. Check and record thermal overload ratings for all motors.

3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main supply, return and exhaust ducts to obtain total CFM. If a Pitot-tube traverse is not practical, the summation of the outlets or inlets may be used. An explanation why a traverse was not made must appear on the appropriate data sheet.

4. Static Pressure - Test and record system static pressures, including suction and discharge static pressure of each fan. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make fan RPM allowances for 50 percent loading of filters.

5. Air Temperature - Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.

6. Zone Ducts - Adjust zone ducts to within design CFM requirements. At least one zone balancing damper shall be completely open.

7. Main Ducts - Adjust main ducts to within design CFM requirements and traverse for total CFM quantities.

8. Branch Ducts - Adjust branch ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

9. Tolerances - Test and balance each diffuser, grille, and register to within 10 percent of design requirements. Test and balance all fans to within 5 percent of design requirements.

10. Identification - Identify the location and area of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

11. Description - Record the size, type, and manufacturer of each diffuser, grille, and register on air outlet data sheets.

12. Minimizing Drafts - Adjust all diffusers, grilles, and registers to minimize drafts in all areas.

13. Test and Balance Engineer shall witness and record all leakage testing of ductwork. Leakage test data shall be included in final Test and Balance Reports.

3.04. WATER SYSTEM PROCEDURES

A. The various water circulating systems shall be filled, purged of air, and put into operation before hydronic balancing by the mechanical contractor.

B. The balancing agency shall perform the following testing and balancing functions in accordance with the AABC National Standards.

C. All domestic re-circulating pumps shall be Tested and Balanced as described below:

1. Strainers - Request that the mechanical contractor clean all strainers.

2. Air Vents - Check all air vents at the high points of the water system and determine if they are installed and operating.

3. Valves - Set all balancing valves to the full-open position for balancing.

4. Pumps - Adjust all pumps and domestic hot water re-circulating water pumps to meet design GPM requirements. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Measure and record operating current and voltage. Check and record thermal overloads installed on all pumps. Record in Test and Balance Report.

5. Tolerances - Proceed to balance all pumps, balance valves to within 5 percent of design requirements.

6. Marking - Mark all settings and record all data after completing the flow readings and coil adjustments.

3.05. DOMESTIC HOT WATER RE-CIRCULATING SYSTEMS PROCEDURES

A. The domestic hot water re-circulating system shall be tested and balanced as indicated on the contract documents including:

1. Balance of circuit setters to design quantities indicated on contract documents.

2. Balance of re-circulating pumps to meet design GPM requirements.

B. Domestic Water Heaters/Generators:

1. Verify that all domestic water heaters have been filled and started by others and are in operation.

2. Test and record outlet temperature of water heater at approximate design recovery.

3. Current and Voltage: As applicable, test and record voltage and amperage, compare data with nameplate limits to ensure water heater elements or burners do not exceed nameplate data.

4. Test discharge temperature and flow rate at all lavatory/hand sink mixing valves. Also measure time period for fixtures to obtain hot water.

3.06. VERIFICATION OF TEMPERATURE CONTROL

A. The balancing agency shall be assisted by the temperature control contractor in verifying the operation and calibration of all temperature control systems. The following tests shall be conducted:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset.

2. Verify that all controlling instruments are calibrated and set for design operating conditions.

3. Verify the accuracy of the final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.

3.07. TEST AND BALANCE REPORTS

A. The test and balance report shall be complete with logs, data, and records as required herein. All logs, data, and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the balancing agency's certified test and balance engineer.

B. Six (6) copies of the test and balance report are required and shall be submitted to the Engineer. If, in the opinion of the Engineer, test results or portions thereof are incomplete or inconclusive, repeat necessary portions of the work to the satisfaction of the Engineer.

C. The report shall contain the following general data in a format selected by the balancing agency:

1. Project Number

2. Contract Number

3. Project Title

4. Project Location

5. Project Architect

6. Project Mechanical Engineer

7. Test & Balance Agency

8. Test & Balance Engineer

9. Construction Manager

10. Mechanical Subcontractor

11. Dates tests were performed

12. Certification

13. Duct Leakage Tests

14. Phone Numbers of all Individuals Listed Above

D. The test and balance report shall be recorded on report forms conforming to the recommended forms in the AABC National Standards.

3.08. TEST REPORT FORMS

A. Air Moving Equipment and Fan Test Forms - Submit fan curve showing design and operating points of operation. Also, record the following on each air-handling equipment, unit heater test form:

1. Manufacturer, model number, serial number, arrangement.

2. All design and manufacturer-rated data.

3. Total actual CFM by traverse if practical. If not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.

4. Suction and discharge static pressure of each fan, as applicable. Include pressure drops across coils, filters, and similar devices.

5. Exhaust air total CFM.

6. Actual operating current, voltage and brake horsepower of each fan motor. For packaged equipment, this includes supply fans, relief air fans, and condenser fans.

7. Final RPM of each fan.

8. Total and external static pressure.

B. Unit Heater Heating -Coil Test Forms - Record the following items on each test form:

1. Manufacturer, location, service.

2. All design and manufacturer's rated data.

3. Rated and actual static pressure drop across each coil.

4. Dry-bulb temperatures entering and leaving each heating coil.

5. Air flow (Design and Actual).

C. Duct Traverse Test Forms:

1. System zone/branch.

2. Duct size.

3. Area.

4. Design velocity.

5. Design air flow.

6. Test velocity.

7. Test airflow.

8. Duct static pressure.

9. Air temperature.

10. Air correction factor.

D. Duct Leakage Test Forms:

1. Description of ductwork under test.

2. Duct design operating pressure.

3. Duct design test static pressure.

4. Duct capacity, air flow.

5. Maximum allowable leakage duct capacity times leak factor.

6. Test apparatus.

a). Blower.

b). Orifice, tube size.

c). Orifice size.

d). Calibrated.

7. Test static pressure.

8. Test orifice differential pressure.

9. Leakage.

E. Air Distribution Test Sheet:

1. Air terminal number.

2. Room number/location.

3. Terminal type.

4. Terminal size.

5. Area factor.

6. Design velocity.

7. Design air flow.

8. Test (final) velocity.

9. Test (final) air flow.

10. Percent of design air flow.

F. Thermostatic Mixing Valve Test Forms

1. Manufacturer, Model Number, Series, Arrangement

2. All manufacturer data.

3. Verify all strainers are clean.

4. Leaving temperature actual and design.

G. Water Heater Test Forms

1. Manufacturer, Model Number, Series

2. All manufacturers' data.

3. Verify all safeties.

4. Record leaving water temperature actual and design.

5. Record electrical characteristics

END OF SECTION

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HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT
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SECTION 23 06 00

HEATING, VENTILATING, AND AIR CONDITIONING EQUIPMENT

PART 1 GENERAL

1.01 GENERAL

A. The Conditions of the Contract and other General Requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 23 Section, *Common Work Results for HVAC* and Division 01 Section *General Requirements.*

1.02 DESCRIPTION

A. The work to be performed shall include all labor, materials and equipment necessary to furnish and install complete, all mechanical equipment as shown on drawings, hereinafter specified or reasonably implied, and leaving the same in satisfactory operation condition. It is the intent that systems be installed complete with all items necessary to accomplish this purpose.

1.03 SUBMITTALS

A. Shop Drawings: Indicate assembly, equipment dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

B. Product Data:

1. Provide literature which indicates dimensions, weights, capacities, ratings, performance, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Provide data of filter media, filter performance data, filter assembly, and filters frames.
3. Provide fan curves with specified operating point clearly plotted.
4. Submit sound power level data for both fan outlet and casing radiation at rated capacity. Submit sound power levels by octave band or sound pressure levels by octave band for all equipment.
5. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

1.04 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of General

Requirements.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store all equipment in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

D. Comply with manufacturer's installation instructions for rigging, unloading and transporting equipment.

E. Protect all motors, shafts, and bearings from weather and construction dust.

1.06 ENVIRONMENTAL REQUIREMENTS

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

1.07 ALTERNATES

A. Refer to Division 01 Section, "Alternates" for description of work under this section affected by alternates.

1.08 LEED REQUIREMENTS

A. Refer to Division 01 Section, "LEED Requirements" for description of work under this Division affected by LEED requirements.

PART 2 PRODUCTS

2.01 RECESSED ELECTRIC CABINET UNIT HEATER

A. Unit heaters shall be blow-through design with motor and fans in the air stream below electric heating bank. Fan discharge shall be baffled to insure even air flow through entire area of heating bank for even outlet temperatures. All models shall be floor or ceiling mounted as scheduled. Leveling bolts and bottom inlets shall be provided. Units shall be Type CU as manufactured by Chromalox, Marcor, Emerson, Trane, Markel, Indeeco, or approved equal.

B. All solid panels of the front, top, and bottom panels shall be internally insulated to provide quiet operation and low surface temperatures. Complete unit assembly shall be listed and approved by Underwriter's Laboratory, Inc.

C. Base color shall be selected by the Architect. Casing shall be given a 5- stage phosphatizing treatment prior to application of high gloss baked enamel finish. Casing top and front shall be 16 gauge with 18 gauge front accent panel. Discharge grille shall be a continuous stamped louver. Front access panel fasteners shall be Phillips head.

D. For safety, the electric heating bank shall consist of metal sheath heating elements. The

elements shall have a copper clad steel sheath for strength and corrosion resistance, and aluminum fins for faster heat transfer.

E. Fin tubes shall be installed or removed individually, and shall be center anchored to insure noiseless expansion and contraction.

F. Automatic reset snap-action type thermal protection shall be furnished through holding coil circuit of the control system relay(s) for protection in the event of overheating due to air blockage from any cause. Thermal protector shall be linear type to sense temperatures the entire length of heating elements, to detect localized overheating from partial air blockages.

G. Motor and fan assembly shall be direct drive on all unit sizes, using extended motor shaft on one fan unit, double extended motor shafts on two fan unit and coupling with hollow steel shafts and end bearing on three, four and five fan units. Two-speed permanent split capacitor type motors with built-in automatic reset motor overload protection shall be standard.

H. Fan shall be forwardly curved double inlet centrifugal type, aluminum construction - and shall be modular in design.

I. Motor and fans shall be mounted on an extra heavy 14 gauge galvanized mounting plate, forming an easily removable assembly. Motor leads shall be plug-in type for easy removal of the motor and fan assembly. Combination two-step, two-heat tamperproof switch shall be located with access through discharge air grille, using Allen key for adjustment.

J. A permanent reusable polyurethane type filter shall be provided. All models shall have filter access through removable front access panel.

K. All recessed units shall have wall-guard or ceiling type recess flanges which protect the wall/ceiling from direct contact and damage when access panels are removed or replaced for normal maintenance. Units are to be fully recessed.

L. Furnish and install aATC system compatible temperature sensor with temperature adjustment range between 50 degrees F and 80 degrees F. Furnish control transformer wiring, thermostat guard programming and all other control components as required.

M. An integral fan delay switch shall be standard, to prevent discharge of cold air, by delaying start-up of the fan motor until heating elements have warmed up. This same fan delay switch shall maintain motor operation after heating elements have been de-energized to dissipate any residual heat.

N. Units shall be equipped as standard with a two speed/two heat selector switch which permits simultaneous tamper-resistant "high-low" adjustment of fan speed and heat output by means of an Allen key though discharge grille.

O. A summer fan switch shall be provided to energize fans only for summertime operation.

P. Units shall have a built-in circuit breaker as a positive disconnecting means per the

National Electrical Code.

2.02 FANS

A. General

1. Provide fans as indicated on the drawings. All fans shall have been tested and their performance rated in accordance with Air Movement and Control Association, Inc., Bulletin 210-85 Test Code and shall be licensed to bear the AMCA Seal. All fans shall carry the AMCA Certified Rating Seal for air and sound. Sound power levels shall be submitted for approval. Fan curves shall be submitted with all fan shop drawings.

2. Fan manufacturer shall submit under what duct configuration (unducted, partially ducted, or ducted) the manufacturer certified the performance of a particular fan or group of fans.

B. In-Line Fans

1. Direct Drive

a. Furnish and install in-line centrifugal direct drive fans of the size, capacity, and electrical characteristics as shown on the contract drawings.

b. Duct mounted in-line shall be of the centrifugal, direct driven in-line type.

The fan housing shall be of the square design, constructed of heavy gauge galvanized steel and shall include square duct mounting collars.

c. Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components. All in-line fans shall be factory insulated. The housing interior shall be insulated with 2-inch acoustical insulation.

d. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

e. Motors shall be permanently lubricated and carefully matched to the fan loads. Motors shall be readily accessible for maintenance. Motors shall be high efficiency type. Furnish and install solid state speed controllers for system balancing.

f. All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.

g. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

h. Fans shall be complete with backdraft damper, and unit mounted solid state speed controller.

i. Fans shall be Model SQ as manufactured by Greenheck, Acme Engineering, Penn Ventilator, Cook or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all equipment may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Verify structure, mounting supports and membrane installations are completed to the proper point to allow installation of roof mounted equipment, where applicable.

C. Examine rough-in requirements for all piping systems to verify actual locations of piping connections prior to installation.

D. Verify that electrical work installation is in accordance with manufacture's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until electrical work is acceptable to equipment installer. Coordinate sizes of all thermal overloads with Division 26.

E. Do not proceed until unsatisfactory conditions have been corrected.

F. Provide wiring diagrams of all equipment as specified in Division 23 Section, *Common Work Results for HVAC.*

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Install all equipment in accordance with manufacturer's installation instructions, in accordance with state and local code requirements, and in accordance with the contract drawings. Install all equipment plumb and level, to tolerances as required by the manufacturer of each item of equipment. Maintain manufacturer recommended clearances around and over all equipment.

B. Coordinate vibration isolation requirements with all equipment in accordance with Division 23 Section, *Vibration Controls for HVAC, Plumbing and Fire Protection Equipment.*

C. Coordinate all electrical requirements with Division 26.

D. Connect all equipment, devices and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including

screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

E. Testing: After installing HVAC equipment, devices and components and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

F. Remove and replace malfunctioning units with new units and retest.

G. All mechanical penetrations or terminations in exterior walls shall be flashed and caulked watertight.

3.03 FIELD QUALITY CONTROL

A. Where indicated provide the services of a factory authorized service representative to examine the field assembly of components, installation, piping, electrical connections, controls, and clearances. Submit factory start-up check list to Engineer for information purposes. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer, and forwarded to Testing and Balancing Agency.

B. Where factory start-up of equipment is not specified, provide field start-up by qualified technician to examine the field assembly of components, installation, piping, electrical connections, controls and clearances. Record equipment manufacturers standard start-up information and submit to Engineer for review. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer, and forwarded to Testing and Balancing Agency.

C. Verify proper motor sizes, voltages, thermal overloads, nameplate data, etc. All equipment voltages and current shall be recorded to insure that motors are operating below their service factors. Test and Balance Engineer shall record electrical data before continuous or permanent operation.

3.04 DEMONSTRATION

A. Where indicated, provide the services of a factory authorized service representative to provide start-up and to demonstrate and train the Owner's maintenance personnel.

B. Place equipment into operation and adjust controls and safeties. Replace damaged or malfunctioning components and controls.

C. Training:

1. Train the Owner's maintenance personnel on start-up and shut-down procedures, trouble shooting procedures, lubrication, servicing procedures and preventative maintenance schedules/procedures. Review with the Owner's personnel, the contents of the operation and maintenance data specified in Division 23 Section, *Common Work Results for HVAC.*

2. Submit operation and maintenance data as soon as possible prior to project close-out. Operations and maintenance data shall be submitted to the Owner for review and comment prior to submission to the Engineer.

3. Schedule training with the Owner through the Architect and/or Engineer with at least seven (7) days prior notice.

D. Contractor shall demonstrate removal and replacement of filters at all pieces of equipment with filters in the prescence of the Owners representative.

3.05 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan and equipment interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils' entering air face.

3.06 ELECTRIC HEATING EQUIPMENT INSTALLATION REQUIREMENTS

A. Examine heating units for compliance with requirements for installation tolerances and other conditions affecting performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. Connect heating units and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

D. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris; repair damaged finishes, including chips, scratches, and abrasions.

3.07 FAN INSTALLATION REQUIREMENTS.

A. Install fans with resilient mounting and flexible electrical leads.

B. Install flexible connections and vibration isolators as specified in Division 23 Section, *Common Work Results for HVAC* and Division 23 Section *Vibration Controls for HVAC, Plumbing and Fire Protection Equipment*. Ensure metal band of connectors are parallel with minimum one inch flex between ductwork and fan while running.

C. Provide safety screens/guards on all fans and permanently mount after final testing and balancing.

D. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fans have been test run under operation.

E. Install fans according to manufacturer's written instructions.

F. Adjust damper linkages for proper damper operation.

G. Lubricate bearings.

H. Mount, install, and wire speed controllers for direct drive fans. Speed controllers for direct drive fans shall be mounted adjacent to fan and wired in accordance with the NEC.

END OF SECTION

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SECTION 230900
AUTOMATIC TEMPERATURE CONTROL
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SECTION 23 09 00

AUTOMATIC TEMPERATURE CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. For General Mechanical Requirements, see Division 23 Section, *Common Work Results for HVAC*, and Division 01, *General Requirements*.

B. Comply with all code requirements and fire safety requirements as specified in Division 21 Section, *Common Work Results for Fire Protection.*

C. Coordinate controls with controlled equipment. Upon completion of the work, calibrate and adjust all controls for proper function. Electric wiring, including interlock wiring for equipment such as ERV's, heat pumps, exhaust fans, ductless units, fans, switches, dampers, etc., shall be furnished and installed under this section. All electrical work shall conform to the applicable requirements of Division 26. All control wiring shall be installed in conduit in accordance with Division 26.

D. Reference is hereby made for this contractor to become familiar with Division 26 of these specifications. Familiarization is for coordination purposes only. The control contractor shall provide all necessary relays, manual override switch, contactors, interlock wiring etc. not provided under Division 26 for the automation of the control systems as required by the sequence of operation. The Mechanical Contractor shall coordinate all requirements with the building Fire Alarm System. The mechanical contractor shall provide all additional devices and interlock wiring required for the automation of the ATC system.

E. Furnish all labor, materials, equipment and services necessary for and incidental to furnishing and installing a complete stand-alone, automatic control system to meet the requirements of the sequence of operation described in Part 4.

F. All labor, material, and equipment to meet the functional intent of the system, as specified herein and as shown on the drawings, shall be included. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, that are required to meet the functional intent, shall be provided without additional cost to the owner.

G. Furnish and install all wiring controls, programming, devices, and equipment to interlock all of the new outbuildings with the ATC system in the Main Dover High School. The ATS system in the main Dover High School is a web based system as installed by Modern Controls.

1.02 QUALITY ASSURANCE

A. The systems shall be complete in all respects, and shall be installed by skilled personnel. The Mechanical Contractor shall have a successful history in the installation and maintenance of automatic temperature control systems similar in size and performance to that specified herein.

B. All electrical wiring in connection with the Automatic Temperature Control System shall be furnished and installed by the Mechanical Contractor. This shall include all interlock wiring between the ERVs, exhaust fans, electric unit heaters, fans, pumps, dampers, and switches.

C. All temperature control and interlock wiring shall be installed in conduit unless otherwise noted on the plans. Power or interlock wiring shall be run in separate conduit from sensor and communications wiring.

D. Identify each item, mounted on the face of a control panel, with an engraved nameplate (1/4") inch high engraved letters minimum). Identify each item of control equipment (except room sensors and thermostats), with stamped tape, firmly attached to equipment (1/4") inch high letters minimum).

E. Thermostats or sensors mounted on outside walls shall be mounted on 1 inch minimum thickness, rigid fiberglass insulating base (or equal).

1.03 GUARANTEE AND INSTRUCTION

A. The control system including all components, parts and assemblies herein specified shall be free from defects in workmanship and materials under normal use and service. After completion of the installation, the Mechanical Contractor shall regulate and adjust all thermostats, control valves, control motors, and other equipment provided under this contract. If within two (2) years from the date of acceptance by Owner any of the equipment herein described is proved to be defective in workmanship or materials, it will be replaced or repaired at no additional cost to the Owner. The Mechanical Contractor shall, after completion, provide any service incidental to the proper performance of the Control System under guarantees outlined above for a period of two (2) years. Normal maintenance of the system is not to be considered part of the guarantee. All corrective modifications made during warranty service periods shall be updated on all user documentation including *as-built* shop drawings.

B. The mechanical contractor shall completely check out, calibrate and test all equipment to insure that the system performs in accordance with the approved specifications and sequences of operation submitted.

C. Upon completion of the work, the control drawings encased in heavy plastic shall be provided where directed. Layout shall show all control equipment and the function of each item indicated.

D. Upon completion of the work, the Mechanical Contractor shall have completely adjusted the entire control system. He shall arrange to instruct the Owner's representative on the operation of the control system for a period of not less than eight (8) hours. All training shall be by the Mechanical Contractor and shall utilize specified manuals and as-built documentation.

1.04 SUBMITTALS

A. Submit complete shop drawings, including component catalog cuts, for approval before starting any control work. Shop drawings shall be in accordance with Division 23 Section, *Common Work Results for HVAC*. Shop drawings shall indicate all control equipment,

arrangements, locations, functions, and description of operation.

B. Upon completion of his work, the Control Contractor shall provide six (6) sets of description of operation and schematic drawings corrected to the as-built condition. This material shall be delivered to the Owner.

C. Submittal shall consist of:

1. Data sheets of all products.
2. Damper, and well and tap schedules showing size, configuration, capacity and location of all equipment.
3. Wiring and piping interconnection diagrams including panel and device power and sources.
4. Equipment lists of all proposed devices and equipment.
5. Sequences of operation.

1.05 ALTERNATES

A. Refer to Division 01 Section, *Alternates* - Alternates for description of work under this section affected by alternates.

1.06 LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

PART 2 PRODUCTS

2.01 WIRING

A. The multi-conductor cable for field wiring of electronic analog sensors shall be minimum No. 22 AWG, 300 volt, thermoplastic with stranded copper wire and 100% shield coverage. The number of conductors in each sensor cable shall be as determined by the Contractor. 2/c #22 shielded cables shall be Belden Cat. #8451 3/c #20 shielded cables shall be Belden Cat. #9770.

B. Individual conductors shall be color coded and in addition shall be numbered in the field to identify the particular terminal to which attached. Field numbering shall be performed with Brady markers wrapped around the wire near the terminal connection. All wires shall be terminated with pressure type connectors suitable for wire size, material and terminal connection.

C. All wiring shall be installed in a designated conduit raceway. The conduit shall conform to Division 26.

D. All junction boxes shall have covers painted *safety green*, and be rigid steel.

2.02 CONTROLLERS

A. Temperature sensor covers shall be locking type, key to open with blank cover. All room

temperature sensor shall be mounted 5'-3 inches above the furnished floor, except in corridors and toilets, which shall be 7'-0 inches. Provide insulating bases where temperature sensors are located on exterior or unconditioned walls. Each temperature sensors shall have adjustable limit stops and adjustable sensitivity. Provide vandal proof locking covers.

2.03 DAMPERS

A. Control Dampers

1. The Mechanical Contractor shall provide all automatic control dampers of the types indicated on the plans and not specified to be integral with other equipment. Frames shall be not less than 16 gauge galvanized steel. Blades shall not be over 6 inches wide airfoil shaped double skin construction of 14 gauge equivalent thickness. Bearings shall be stainless steel sleeves with ½" inch shafts. Blade edge seals shall be vinyl blade with flexible metal compressible jamb seals of the tight-seal spring type. Dampers and seals shall be suitable for temperature ranges of -40 to 250 degrees F.

2. All proportional control dampers shall be opposed blade type and all two-position dampers shall be parallel blade type.

3. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6 inches.

4. Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage and flow characteristic data for all control dampers with the temperature control submittal. Maximum leakage shall be 3 CFM/Sq. Ft. at static pressure of 1 inch W.C. for a damper width of 48 inches.

5. Where ultra-low leakage dampers are specified the blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage to 1/2 percent at applied static pressure.

6. Low pressure rectangular control dampers shall be Type CD60 airfoil low leakage damper as manufactured by Ruskin or as approved equal of American Warming and Ventilating, Air Balance and Arrow. Round control dampers shall be Type CERS25 with blade edge seals as manufactured by Ruskin or as approved equal.

B. Damper Operators

1. Electric damper actuators shall be properly sized to provide sufficient torque to position the damper throughout its operating range.

2. In general, where operators are sequenced with other operators they shall be provided with positive positioning relays having adjustable operating ranges and starting points to permit adjustment of the control sequence as required by the operating characteristics of the system. However, where operators for sequencing valves are located in confined spaces within terminal units, springs with pre-selected ranges to provide necessary sequencing may be used.

3. Electric actuators requiring a 24 VAC power supply will be utilized. All motors will have a cover mounted 120/24VAC transformer. Motors shall be specifically designed and sized with proper torque according to requirements of the device it is to be used on (i.e.: valve, damper). Each actuator will accept the proper control input as the system is designed, (i.e.,: floating, 0-10VDC, 4-20Ma etc.) without the need for any additional interface devices.

2.04 CONTROL PANELS

A. Where required or indicated furnish and install local panels for indicating controllers, switches, relays, etc. Control panels shall be fully enclosed cabinets, all steel construction and shall meet the requirements of NEMA 1 enclosures. Cabinet shall have piano hinged door with a locking latch. All cabinet locks shall use common key. Provide means of storing control system instructions and drawings inside cabinet for future reference. Panel shall be wall mounted or free standing and located where directed by the Contract Drawings or Engineer. All gauges and switches in the face of panels shall be identified with micarta nameplates with etched white filled letters not less than one (1) inch high.

2.05 MISCELLANEOUS ELECTRICAL DEVICES

A. Electric Actuators. All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with electric actuators which shall be sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close off as specified.

1. Where two or more actuators are to be operated in sequence with each other, sequencing shall be by spring range, pilot positioners, or by digital sequencing with separate analog outputs, as specified in the sequence of operation.

B. Aquastats shall be line voltage strap on type with single pole, single throw switching. Switches shall have an adequate rating for the applied load. All wiring from aquastats to domestic recirculating pumps shall be by ATC Contractor.

C. Duct Smoke Detectors shall be furnished by Division 26 and installed under Division 23. They shall be designed to provide detection of combustion gases and fire and smoke in air conditioning and ventilating duct systems in compliance with the National Fire Protection Association and Underwriters Laboratories, Inc. Standard U.L. 167.

D. Unless otherwise specified, for low voltage circuits, use NFPA 70 Type T, TF, TW, THW, THWN, R, RH, RF-2, or FF-2 of 20 gauge and larger except low voltage dc and electronic circuits carrying less than 0.5 amperes cables 2 of 2 or more conductors, not smaller than 22 gauge if not shielded, may be used in lieu of individual wires. Use shielded cables carrying circuits sensitive to external fields. Terminate cables in push-on, solder or screw type terminal strips. Do not tap cables at intermediate points. Do not create intermediate junction points.

E. Provide E.M.T. raceway systems for all wiring in accordance with NFPA 70, and Electrical Specification, Division 26. Wiring shall be plenum rated in areas of mechanical air transfer.

F. Relays shall be open contact, electronic type with dust-proof enclosures having capacity suitable for the load controlled.

G. Provide all necessary wiring, relays, contacts, etc., to prevent nuisance alarms of alarm points during *Off, Unoccupied or Test* modes.

H. Transformers other than those used in bridge circuits shall have primaries wound for the correct control circuit voltage. Size to have capacity to operate simultaneously all apparatus served and in addition be capable of carrying a 25 percent overload for one hour. Enclose transformer in a steel cabinet with conduit connections, and provide a disconnect switch on the primary side, and a fuse cut-out on the secondary side.

I. Operate electric and electronic mechanical controls at maximum of 120 volts or less. Where not provided under Division 26, Electrical, provide voltage transformers and isolating relays where control system must operate at voltage other than that of line voltage.

J. Wiring shall be performed in accordance with the applicable provision of Division 26, Electrical Work. All temperature control wiring shall be run in E.M.T. in mechanical spaces in raceway and in accordance with Division 26. Furnish plenum rated cable in all areas of mechanical air transfer.

K. Low voltage cable may be utilized in accessible locations. This cable shall be run *open* and ty-wrapped accordingly.

2.06 SPACE TEMPERATURE SENSORS

A. Space temperature sensors for unit heaters, and other temperature dependent equipment shall be single stage, low voltage, DDC compatible sensors that can be interfaced with the ATC system. Furnish units with 50 degree to 80 degree F adjustable range.

B. Provide transformers as necessary to accomplish sequence of operation.

C. Provide locking vandal-proof covers on all space temperature sensors.

D. All space temperature sensor shall be programmed to provide occupied/unoccupied settings, start/stop optimization, remote re-set, and shall be interlocked and report to the DDC system.

2.07 MISCELLANEOUS DEVICES

A. Aquastats shall be line voltage strap-on type for single pole, single throw switching. Aquastats shall be provided, wired, and installed by mechanical contractors.

PART 3 EXECUTION

3.01 GENERAL

A. The Automatic Temperature Control System shall be designed, installed, and commissioned in a turn key fully implemented and operational manner.

3.02 INSTALLATION & SUPERVISION

A. All wiring shall be properly supported and run in a neat and workmanlike manner. All wiring exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent restriction to devices and terminals.

B. The Mechanical Contractor shall be responsible for all electrical installation required for a fully functional control and automation system and not shown on the electrical plans or required by the electrical specifications. All wiring shall be in accordance to all local and national codes.

1. All line voltage wiring, all wiring exposed, and all wiring in equipment rooms shall be installed in conduit in accordance to the electrical specifications.

2. All electric and electronic wiring shall be #18 AWG minimum THHN and shielded if required.

C. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

D. Install in accordance with manufacturers instructions.

E. Check and verify location of temperature sensors, and other exposed control sensors with plans and room details before installation. Align with lighting switches.

F. Provide separable sockets for liquids and flanges for air bulb elements.

G. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

3.03 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

E. Verify that conditioned power supply is available to the control units. Verify that field end devices, wiring, and tubing is installed prior to installation proceeding.

3.04 INTERLOCK REQUIREMENTS

A. The fan and equipment interlock requirements are as required herein and as scheduled on the contract drawings.

B. Furnish and install all necessary relays, transformer, contactors, wiring, conduit, and accessories to perform fan and equipment interlocks.

C. Unless otherwise noted, fan interlocks shall be arranged such that dampers associated with fan shall be open when fan starts and close when fan stops.

3.05 SUBMITTALS FOR REVIEW

A. Shop Drawings: Indicate mechanical system controlled and control system components.

1. Label with settings, adjustable range of control and limits. Include written description of control sequence.
2. Include flow diagrams for each control system, graphically depicting control logic.

3.06 SUBMITTALS AT PROJECT CLOSEOUT

A. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

PART 4 SEQUENCES OF OPERATION

4.01 ELECTRIC DOMESTIC HOT WATER HEATER WITH RE-CIRC PUMP.

A. General

1. The electric domestic hot water heaters shall be tied into the ATC system to provide start/stop optimization and control. ATC contractor shall provide contactors as required for start/stop optimization. Water heater systems in buildings that will be drained down in the winter shall be interlocked with ATC system to allow remote start/stop of water heater and recirc pump.

2. The leaving water temperature of each water heater shall be monitored and report back to central monitoring system.

3. Each domestic hot water heater re-circ pump shall be controlled by a line mounted aquastat. All wiring, relays, aquastats, etc., shall be provided and installed by ATC subcontractor. Domestic water re-circulating pumps shall be de-energized when system is shut-down during summer and/or lengthy unoccupied periods.

4. On a fall in recirc. water temperature below set point the recirc. pump shall energize. Reverse sequence shall occur when aquastat is satisfied.

5. Provide and install differential pressure switch or current sensor to determine the status of all domestic re-circ pumps.

B. System Operation

1. Each electric domestic water heater shall be furnished with factory package controls to maintain a constant leaving temperature of 125 degrees F (adjustable)

4.02 ELECTRIC UNIT HEATERS

A. General

1. The electric unit heaters shall be provided with DDC controls to allow programmable start/stop occupied/unoccupied schedules, manual override, and remote set point adjustable.

2. The ATC subcontractor shall install controls, interlock wiring, sensors, and control wiring for a complete and operational system.

3. The unit heater occupied periods and setpoints shall be programmed into the DDC system with the Owner's input. Unit heaters shall only operate in occupied mode when activated automatically via DDC system or by manual override switch.

B. System Operation:

1. On a fall in room temperature to 70 degrees F (adjustable), the space sensor, T-1 shall energize unit heater fans and heating elements in sequence to maintain a space temperature of 70 degrees F (adjustable). The reverse sequence shall occur upon a rise in space temperature above set point.

2. During unoccupied periods the space temperature sensors shall be reset to an unoccupied temperature of 55°F (adjustable) and the fan/heating elements shall cycle to maintain the unoccupied setting.

C. Manual Override Control

1. All unit heaters in each building shall be interlocked with a manual override switch that will ignore the pre-programmed known events/schedules. The manual override control switch shall allow all of the unit heaters in a building to be manually overridden from unoccupied mode to occupied mode for a pre-programmed time period (90 minutes – adjustable). Label the common switch in each building as the "Heating system manual override switch".

2. Furnish and install a manual override switch (in each outbuilding containing unit heaters) that when activated will enable all of the unit heaters in the same outbuilding to be changed from unoccupied mode to occupied mode. The unit heaters shall operate to maintain the occupied setpoints for a timed period (90 minutes – adjustable) regardless of the known event program schedule.

3. The reverse sequence shall occur when the heating system manual override switch is de-energized.

4. All wiring from heating system manual override switch to unit heaters, DDC system, etc… shall be installed under this Division of specifications.

4.03 EXHAUST FANS (EXHAUST FAN #1, 2, & 3)

A. General

1. Whenever the exhaust air fan is energized, associated motor operated damper, D-1 shall be in wide open position.

2. The motor operated damper shall fail in the closed position.

3. Provide differential pressure sensor or current sensor to determine status of each exhaust air fan.

4. Interlock exhaust fans with DDC system to allow automatic scheduling for known events. Whenever a known event is scheduled on the DDC system the exhaust fans shall operate for a fixed, software timed period. Once the known event is over the exhaust fans shall return to the off position.

5. Coordinate with Owner to program all known events and times for exhaust fans to be operational.

B. Manual Override Control:

1. The exhaust fans listed above shall each also have provisions for a manual override that will ignore the pre-programmed known events/schedules. The manual override control shall allow the outbuilding exhaust fans to be manually energized for a pre-programmed time period 90 minutes (adjustable). Label the switch as “Exhaust Fan Manual Override Switch”.

2. Furnish and install a manual override switch that when activated shall provide building occupants with a timed period 90 minutes (adjustable) where the exhaust fan is operational regardless of the known event programmed schedule. When the manual override switch is activated the exhaust fan motor operated damper, D-1, shall open and the exhaust fan shall operate continuously for the timed period (90 minutes – adjustable).

3. The reverse sequence shall occur when the manual override wall switch is de-energized.

4. All wiring from manual override switch to fan/damper shall be installed under this Division of specifications.

END OF SECTION

DIVISION 23 SECTION 233000
HVAC AIR DISTRIBUTION

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SECTION 23 30 00

HVAC AIR DISTRIBUTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers, and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Division 01 Sections related to LEED.

2. Product Data for Credit MR 5.1 (and MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Division 01 Sections related to LEED.

1.02 SUMMARY

A. For General Mechanical Requirements, see Division 23 Section, "Common Work Results for HVAC" and Division 01, "General Requirements".

B. The fabrication and installation of all ductwork, together with related equipment, shall comply with the standards of the National Fire Protection Association, as set forth in NFPA Standard No. 90A, as well as with the requirements of the Sheet Metal and Air Conditioning Contractors' National Association, Inc., and the latest edition of the ASHRAE Guide.

C. All duct sizes shown are net inside clear dimensions. Where internal duct lining is used, increase duct sizes accordingly to provide the indicated net free area. Unless otherwise indicated size runouts, drops, and connections to grilles, registers, diffusers, fans, coils, louvers, filters, and other equipment to the full size of the equipment connection.

D. Minor changes may be made in duct sizes where required to fit the available space, provided the indicated net free area and approximate aspect ratio are maintained.

E. Smoothly transition all ductwork to prevent excessive or unnecessary turbulence or pressure loss.

F. All exposed ductwork in finished areas shall be painted in color as indicated by Architect. All ductwork requiring paint shall be constructed of paint grade galvanized sheet steel with a paintable finish.

1.03 REFERENCES

A. ASTM A 36 - Structural Steel.

B. ASTM A 90 - Weight of coating on Zinc-Coated (Galvanized) Iron or Steel Articles.

C. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

D. ASTM A 366 - Steel, Sheet, Carbon, Cold Rolled, Commercial Quality.

E. ASTM A 480 - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.

F. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

G. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

H. ASTM A 568 - Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.

I. ASTM A 569 - Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.

J. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

K. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

L. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

M. SMACNA - HVAC Air Duct Leakage Test Manual.

N. UL 181 - Factory-Made Air Ducts and Connectors.

O. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

P. NFPA 70 - National Electrical Code.

Q. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.04 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes 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.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the projects specified in this section with minimum five (5) years documented experience.

B. Installer: Company specializing in performing the work of this section with minimum five (5) years experience.

1.06 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA- 90A, and NFPA-90B.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturer.

B. Maintain temperatures during and after installation of duct sealants.

1.08 ALTERNATES

A. Refer to Division 01 Section, “Alternates” for description of work under this section affected by alternates.

1.09 LEED REQUIREMENTS

A. Refer to Division 01 Section “LEED Requirements” for description of work under this Division affected by LEED Requirements.

PART 2 PRODUCTS

2.01 DUCTWORK

A. Unless otherwise indicated or specified, fabricate ductwork of galvanized sheet steel, stainless steel, or aluminum conforming to Commercial Designation 3003 Temper H14 and Duct Sheet. Duct gages, jointing and reinforcement shall conform to Tables 4, 5, 6 and 7, as applicable, Chapter I of the latest *ASHRAE Guide and Data Book*. Construction details shall conform to Section I and Section II, as applicable, of *Duct Manual and Sheet Metal Construction for Ventilation and Air Conditioning Systems* as published by Sheet Metal and Air Conditioning Contractors' Association, Inc.

B. Erect sheet metal ductwork in a first-class, workmanlike manner secured in place rigidly and permanently. Provide suitable hangers, securely attached to building construction with bolts, clips or inserts. Hangers shall be structural shapes, flat bars, or formed strap hangers; use of wire will not be permitted. Hangers shall not pass through or be inside duct. Support vertical ducts passing through floors by angles riveted to duct and resting either on floor or on brackets secured to building construction. All space around ducts where they pass through any walls, floors, ceilings, or roofs shall be sealed tight with incombustible inert material. Do not arrange ducts so as to impair the effectiveness of fireproofing around structural members. Provide sheet metal flanged collars around exposed ducts passing through walls, floors, or ceilings to provide finished appearance. Seal all duct joints and seams including supply, return, outside air, combustion air, relief air, ventilation air and exhaust ductwork with *Hardcast* Sealing System as manufactured

by Hardcast, Inc., or approved equal.

C. Flexible connections of neoprene or other NFPA approved non-inflammable fabric shall be provided in the duct system at all fan inlet and outlet connections.

D. Provide cut turning vanes in all duct turns where centerline radius is located. Turning vanes shall be air-foil type with extended trailing edges. Fabricate to comply with SMACNA Sheet Metal Construction for Ventilation and Air Conditioning Systems Manual.

E. Provide duct collars and angle iron framework for mounting of automatic dampers.

F. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

G. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

H. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

I. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4-inch (100 mm) cemented slip joint, brazed or electric welded. Prime coat welded joints.

J. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

K. Fasteners: Rivets, bolts, or sheet metal screws.

L. Hanger Rods: ASTM A36 - Galvanized steel; threaded both ends, threaded one end, or continuously threaded.

2.02 DUCT SYSTEMS

A. All exhaust air ductwork shall be constructed for low pressure service (2 inch W.G.).

2.03 DUCT CONSTRUCTION

A. Rectangular and/or Round Ductwork (Low Pressure):

1. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having G-90 Zinc coating in conformance with ASTM A90.

2. Make allowance for internal duct lining where required. Sizes shown on the drawings are inside clear dimensions.

3. Determine duct gauges for the longest duct side and use for all four sides. Joints and reinforcing requirements apply to the longest duct side.

4. Reinforce all ducts to prevent buckling, vibration, or noise as recommended in the referenced construction standards, and as required to suit the installed conditions.

5. Do not cross break duct which will receive rigid insulation covering.

6. Where tap sizes of divided-flow fittings are not indicated, make branch and main/connection sizes proportional to their respective air flows and maintain uniform transverse velocities in the fitting.

7. Make radius elbows and radius tee connection with throat radius equal to or greater than the width of the duct. Use vaned elbows where shown and where radius elbows will not fit the space, and in all square bends.

8. Turning vanes shall be the air-foil type with extended trailing edges, 36-inch maximum vane length. Where longer vanes are required, use two or more sets of vanes with intermediate runners securely fastened together.

9. Bolt, screw, rivet, or spot weld reinforcing members securely to the duct on not less than 6-inch centers.

10. Where ducts are open-ended without grilles, registers, or other means of stiffening, reinforce and stiffen the open end with standing seams or an angle frame. Provide rolled edges to prevent any exposed sharp edges.

11. Paint all cut ends on galvanized angles, rods, and other uncoated surfaces with aluminum paint.

12. Where ductwork is not painted or otherwise finished, remove all exposed traces of joint sealers, manufacturer's identification and other markings.

13. Aluminum sheet shall be 3003 H14 alloy or duct sheet, 16,000 psi minimum tensile strength, and capable of being formed to a Pittsburgh lock seam.

14. Determine duct gauges per SMACNA based on duct size and pressure indicated.

2.04 AIR VOLUME CONTROLS

A. Furnish and install air volume control devices where indicated and where required to adjust and balance air flow in the systems, whether indicated or not. Volume dampers shall be provided in all branch ducts serving air outlets and inlets.

B. Manual volume dampers in ductwork shall be factory-assembled units with rigid frame, opposed-blade action, and locking quadrant operator. Mark the extended damper shaft and align the operating handle to indicate the blade position. Dampers shall be as manufactured by Ruskin, American Warming and Ventilating, Inc., Arrow, or approved equal. Rectangular dampers shall be Type MD35, with steel channel frame, 16 gauge

steel blades, 9 inch maximum blade spacing, low pressure, nylon bearings, galvanized finish with aluminum paint touch up. Round manual balancing dampers shall be Type MDRS25 manufactured by Ruskin, Arrow, American Warming and Ventilating, Inc., or as approved equal. When external insulation is to be applied, provide sheet metal standoffs on all manual volume dampers.

C. Motor-operated dampers shall be as hereinafter specified under Division 23 Section, "Instrumentation and Controls of HVAC & Plumbing System".

D. Duct turning vanes shall be Tuttle & Bailey *Ducturns*, or approved equal.

E. Furnish and install duct collars and angle iron frames for the installation of ATC dampers.

F. Where volume dampers are installed in exposed finished spaces locate damper handle on top of duct.

2.05 DUCT ACCESS DOORS

A. Furnish and install adequately sized duct access doors at air measuring devices, motor-operated dampers, and duct smoke detectors and other locations where indicated and required for duct access. Doors shall be the continuous piano-hinged type with approved latches and neoprene compression-type gaskets with 1 inch thick fiberglass double skin and shall be Ruskin Model ADH22, Air Balance, Inc., FSA-100 or as approved equal. Stiffen ductwork at door openings. Where doors are installed in insulated ductwork, provide equivalent insulation in the door assembly. Where access doors are installed in the fire-rated partitions, provide *Fire Seal* access doors as manufactured by Air Balance, Inc., or approved equal, UL approved, meeting the rating of the enclosure in which the access door is installed.

B. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

2.06 AIR TERMINAL DEVICES

A. Furnish and install air supply, return, exhaust devices of sizes and capacities as scheduled on the drawings. Catalog numbers shown are Metalaire, Inc., products for equipment which have been found suitable for the application. Products of Tuttle & Bailey, Anemostat, Division of Hart & Cooley, Carnes, Titus, Price, or approved equal will be considered only if performance characteristics including throw, drop, pressure loss, sound pressure level, etc., are equal to or better than the performance characteristics of the specified products. All air devices shall be ADC certified. Ductwork behind registers, grilles and diffusers shall be given two coats of flat black paint. Perimeter of all ceiling diffusers shall be caulked to provide a neat, aesthetic appearance.

B. Device Schedule:

AIR DEVICE SCHEDULE

Device	Accessories	Finish

AIR DEVICE SCHEDULE		
Exhaust Register, Gypboard, Surface Mount		
MetalAire, Model RHD Rectangular Registers (Surface Mount)	Integral opposed blade damper	Off-white baked enamel finish
	45 degree angled deflecting vanes	
	All aluminum construction	
Exhaust, Register, Lay-in Tile		
MetalAire, Model RHD Rectangular Registers	Integral opposed blade damper	Off-white baked enamel finish
	45 degree angled deflecting vanes	
	All aluminum construction	
	Auxiliary panel for lay-in tile installation	

C. Where air terminal devices are installed in duct collars or branches, furnish and install air extractors. Furnish and install control grids, volume dampers, and/or other accessories necessary to ensure uniform air flow across the terminal devices. Accessories shall be of the same material as the terminal device. Install fixed blade terminals so that blades block the normal line of vision. Furnish three (3) of each type of removable key operators.

D. Contractor shall determine frame and mounting type as per type of ceiling as shown on Architectural drawings.

E. Noise Criteria: All air devices shall be sized and selected to limit maximum NC (noise criteria) levels to 30.

2.07 LOUVER BLANK-OFF PANELS

A. Insulated, Blank-Off Panels: Laminated panels consisting of insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: 2 inches (50mm)
2. Metal Facing Sheets: Aluminum sheet, not less than .032 inch (.81mm) nominal thickness.
3. Insulating Core: Rigid, glass-fiber-board insulation or extruded-polystyrene foam
4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer’s standard extruded-aluminum-channel frames, not less than .080 inch (2.03mm) nominal thickness with corners mitered and with same finish as panels.

5. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
6. Panel Finish: Same finish applied to louvers.
7. Attach blank-off panels with stainless steel sheet metal screws.
8. Cover all unused openings in louvers.

2.08 OPEN END DUCTS (OED)

A. Whether indicated on plans or not, all open-ended ducts shall be provided with a protective screen.

B. All open-ended ducts shall be furnished with a 12 gauge ½ inch x ½ inch aluminum mesh screen. Screens shall be permanently installed in a removable frame, and the frame shall be attached to the open-ended duct in a neat, workmanship-like manner without any exposed edges or sharp surfaces.

C. Screen shall be attached to a ¾ inch x 1/8 inch continuous galvanized perimeter frame. Install duct stiffeners greater than 16 inches in any direction at open-ended ducts.

2.9 DUCT SEALANTS AND ADHESIVES

A. All ductwork shall be sealed, including low pressure exhaust systems. Transverse joints and longitudinal seams in duct systems shall be sealed with a duct sealant of the type specified hereinafter in Section 1, 2, or 3, or with a tape sealing system as specified in Section 4. Spiral lockseams are not longitudinal seams and do not require duct sealant. All seams and joints shall require duct sealant suitable for the pressure rating and installation application. All sealants shall exceed 500 hours without becoming brittle under ASTM-D572 test conditions (oxygen bomb), unless specified otherwise. No surface preparation or solvent cleaning shall be necessary to remove light coatings of oil and dust before applying sealant unless specified otherwise. Flanged joints shall be sealed according to Section 5. Construction joints that are not fully welded shall be sealed according to Section 6. Adhesive to secure insulation to metal surfaces shall be that specified in Section 7.

1. Assembly joints to be installed indoors shall be sealed with United Duct Sealer or equivalent, which is a solvent-based (polymeric rubber) sealant formulated to withstand temperatures from –29 degrees F to +150 degrees F. Sealant shall have a UL Classification marking with a flame spread of 15 and smoke developed of 0 when applied to inorganic reinforced cement board, both at a coverage of 31 square feet per gallon. Sealant shall exceed 750 hours without becoming brittle under ASTM-D572 test conditions (oxygen bomb).

2. Assembly joints to be installed indoors and outdoors shall be sealed with UNI-WEATHER™ duct sealer or equivalent, which is a solvent-based (Neoprene-phenolic mastic) sealant formulated to withstand temperatures from -20 to +300 degrees Fahrenheit. Sealant shall have a UL Classification marking with a flame spread of 5 and smoke developed of 0 when applied to 18-gauge galvanized steel and a flame spread of 5 and smoke developed of 5 when applied to inorganic reinforced cement board, both at a coverage of 53 square feet per gallon. Sealant shall exceed 1,000 hours under ASTM-D572 test conditions (oxygen bomb) without becoming brittle and 500 hours in QUV accelerated-exterior-aging

apparatus without degradation (under ASTM-C732 test conditions).

3. Assembly joints to be installed indoors shall be sealed with UNI-GRIP™ duct sealer or equivalent, which is a water-based (vinyl-acrylic polymer) sealant formulated to withstand temperatures from –25 degrees to +200 degrees Fahrenheit. Surfaces to be sealed should be clean, dry, and free from oil, grease, and dirt. Sealant shall be nonflammable (wet) and fire retardant. Sealant shall have a UL Classification marking with a flame spread of 5 and smoke developed of 5 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, both at a coverage of 40 square feet per gallon.

4. Assembly joints shall be sealed with UNI-CAST® tape sealing system or equivalent, which is a combination of an adhesive activator and woven-fiber tape impregnated with a gypsum mineral compound. Modified acrylic/silicone activator (MTA-20 for indoor use) reacts exothermically with the tape to form a hard, airtight seal. Sealant shall be formulated to withstand temperatures from –40 degrees F to +200 degrees Fahrenheit. Combination of tape and MTA-20 adhesive shall have a flame spread and smoke developed of 0. Do not use for outdoors.

5. Flanged joints to be installed indoors shall be sealed with UNI-GASKET™ flange sealer or equivalent, which has a synthetic elastomer base and is formulated to withstand temperatures from –20 degrees F to +150 degrees F. Sealant shall have a UL Classification marking with a flame spread of 5 and smoke developed of 5 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 5 when applied to inorganic reinforced cement board, both at a coverage of 80 square feet per gallon.

6. Where duct fittings are constructed with standing seam or spot-welded techniques, all construction joints shall be sealed with UNI-WELD™ metal cement or equivalent, which is composed of neoprene rubber, resins, and inert reinforcing material dispersed in a petroleum distillate. Sealant shall be formulated to withstand temperatures from –20 degrees F to +225 degrees F. Sealant shall have a UL Classification marking with a flame spread of 0 and smoke developed of 0 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, tested as applied in two 1/8 inch beads 8 inches on center.

7. Where insulation is to be secured to metal surfaces, the adhesive used shall be UNI-TACK™ duct liner adhesive or equivalent, which is a water-based, vinyl-acrylic copolymer formulated to withstand temperatures from –20 degrees Fahrenheit to +160 degrees Fahrenheit. Adhesive shall have a UL Classification marking with a flame spread of 0 and smoke developed of 0 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, both at a coverage of 267 square feet per gallon.

B. Manufacturers: Duct Mate, United McGill, Semco, Elgen, Childers, Benjamin Foster, or as approved equal.

PART 3 EXECUTION

3.01 DUCT INSTALLATION REQUIREMENTS

A. Coordinate ductwork with other work and install ducts at proper elevations and locations to maintain indicated ceiling heights and clearances. Provide all elbows, transitions, offsets, connections, and other fittings necessary to fit the work into place or to connect to equipment or diffusers. Method of duct support connection to structure and slabs shall be approved by Structural Engineer, and Shop Drawings shall be submitted.

B. Substantially support ductwork with structural shapes, flat bars, or formed strap hangers securely attached to the building structure by means of bolts, clamps, or inserts. Support vertical ducts by angles attached to the duct and resting on the floor or supported by brackets or hangers attached to the building structure. Strap hangers shall be 16-gauge minimum galvanized steel formed under the bottom edge of duct. Use square ¼ inch thick washers tight against the bend on upper strap attachments to horizontal surfaces. Place all supports external to the ductwork and out of the air stream. Provide additional supports at coils and other concentrated loads. Arrange supports so that duct weight is not transmitted to ceilings, fans or other equipment.

C. Prevent direct contact between ductwork and building surfaces or other equipment. Where ducts pass through walls, partitions, floors, ceilings, or roofs, pack and seal the space around the duct with an approved fire-safe inert material. Provide flanged duct escutcheons at all exposed ducts that pass through walls, partitions, floors, and ceilings.

D. Use galvanized (compatible) corrosion-resistant hangers, supports, brackets, and hardware.

E. Furnish and install NFPA-approved duct connections where shown and at all connections to fans, air handling units, and similar rotating equipment. Use glass-reinforced neoprene fabric, roll-formed to sheet metal strips or flanges. Support adjacent ductwork to provide sufficient slack in the connection.

F. See NFPA 90A, and latest publication of SMACNA. Prevent direct contact between ductwork and building surfaces or other equipment. The opening in the construction around the duct shall not exceed one-inch average clearance on all sides. Where ducts pass through walls, partitions, floors, ceilings, or roofs, pack and seal the space around the duct with an approved fire-safe inert material capable of preventing the passage of flame and hot gases sufficiently to ignite cotton waste when subjected to the same NFPA 251 Time-Temperature Conditions required for fire barrier penetration. All exposed duct penetrations shall be finished with a sheet metal field erected flange escutcheon to form a neat appearance.

G. Coordinate duct installation with the requirements of Division 23 Section, “Vibration Controls for HVAC, Plumbing & Fire Protection Equipment”.

H. Install in accordance with manufacturer’s instructions.

I. Install and seal ducts in accordance with SMACNA *HVAC Duct Construction Standards - Metal and Flexible.*

J. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.

K. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

L. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

M. Use crimp joints, with or without bead, for joining round duct sizes eight (8) inches and smaller with crimp in direction of air flow.

N. Use double nuts and lock washers on threaded rod supports.

O. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork systems.

3.02 ACCESSORY INSTALLATION REQUIREMENTS

A. Install accessories in accordance with manufacturer's instruction, NFPA 90A, and SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, duct detectors, air flow monitoring stations, and elsewhere as indicated. Review locations prior to fabrication.

C. Provide duct test holes where required for testing and balancing purposes. Review locations with Test and Balance Engineer prior to installation.

D. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment and supported by vibration isolators. Refer to Division 23 Section, "Vibration Control for HVAC and Plumbing Systems".

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum duct widths from duct take-off.

F. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

G. Install diffusers, registers, and grilles to ductwork with airtight construction.

H. Check location of all air outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangements.

I. Install duct accessories according to applicable details shown in SMACNA's *HVAC Duct Construction Standards--Metal and Flexible* for metal ducts.

J. Install volume dampers in lined duct; avoid damage to and erosion of duct liner.

K. Provide test holes at fan inlet and outlet and elsewhere as indicated.

L. Adjust duct accessories for proper settings.

3.03 CLEANING

A. Clean duct system and force air at high velocity through ducts to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

B. Clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

C. Ductwork shall be cleaned in accordance with "Duct Cleanliness for New Construction (SMACNA 2000)", and shall achieve a "Basic" cleanliness level.

3.04 LEAKAGE TESTS

A. All low pressure sheet metal ductwork shall undergo leakage tests at 2 inch W.G. Tests shall be accomplished under this section and witnessed as specified under Division 23 Section, "Testing, Adjusting, and Balancing for HVAC and Plumbing".

B. Leakage from each duct system shall not exceed 5 percent for low pressure systems of the normal air handling capacity of the system. If the system ductwork is tested in sections, the leakage shall not exceed ½ of 1 percent of the CFM to be handled by that section, and the total leakage of the system shall not exceed 1 percent of the total system CFM. Test pressure shall not exceed the pressure limits of the duct construction as defined in SMACNA *High Pressure Duct Construction Standards*. Repair all leaks which are audible, regardless of the leakage rate of the duct system as a whole, by remaking the entire defective joint or seam. Spot sealing of ducts in place *will not* be acceptable.

C. All duct accessories, including but not limited to volume dampers, ATC sensors, duct detectors, duct coils shall be installed prior to duct leakage testing.

D. Submit a complete report of the ductwork leakage tests to the Architect and include final approved copies in test and balance reports.

3.05 DUCTWORK IDENTIFICATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. All ductwork shall be identified with painted background marked with the name of the service with arrows to indicate flow direction. Color Code and System Identification shall comply with ANSI Standards.

C. Marking shall be plain block letters, stenciled on ductwork (above and below ceilings) and shall be located near each branch connection and at least every ten feet on straight runs of ductwork. Where ductwork is aligned adjacent to each other, markings shall be neatly lined up. All markings shall be located in such a manner as to be easily legible

from the floor.

D. Identify ductwork with plastic nameplates or stenciled painting. Identify with air handling unit identification and area served.

E. Length of color field for ductwork shall be 32 inches. Lettering shall be minimum 3-1/2 inches high.

END OF SECTION

SECTION 323113

CHAIN-LINK FENCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes chain-link fences and swing gates.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   1. Provide fencing system including top and bottom rails, single and double swing gates with appropriate cross bracing and post size, post caps, closing and locking hardware.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each polymer-coated product and for each color and texture specified, in 12 inch lengths for components and on full-sized units for accessories.

D. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of chain-link fence and gate, from manufacturer.

B. Product Test Reports: For framing strength according to ASTM F 1043.

C. Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which 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, deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Period: Five years from date of Substantial Completion.

1.7 FIELD CONDITIONS: Coordinate fencing work with location and installation of other work including planting.

PART 2 - PRODUCTS

2.1 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. Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: 6’-0” (site perimeter/athletic field perimeter) and 3’-6” (track perimeter)
2. Steel Wire Fabric: Wire with a diameter of 0.192 inch

a. Mesh Size: 2 inches.
b. Polymer-Coated Fabric: ASTM F 668, over coated steel wire.

1) Color: Black, complying with ASTM F 934 (Athletic field and track perimeter only)

3. Selvage: Knuckled at both selvages. Install fabric with minimum selvage extending above and below rails.

2.2 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:

1. Fence Height: 6’-0”
2. Light Industrial Strength.

a. Line Post: 2.375 inches in diameter, or as approved
b. End, Corner and Pull Post: 2.875 inches

B. Horizontal Framework Members:
1. Top and bottom rails complying with ASTM F 1043.
2. Brace Rails: Comply with ASTM F 1043.

3. Metallic Coating for Steel Framing:

    a. Type A zinc coating.
    b. Type B zinc with organic overcoat.
    c. External, Type B zinc with organic overcoat and internal, Type D zinc-pigmented coating.
    d. Type C, Zn-5-Al-MM alloy coating.
    e. Coatings: Any coating above.

4. Polymer coating over metallic coating.

    a. Color: Black, complying with ASTM F 934 (Athletic field and track perimeter only)

2.3 SWING GATES

A. General: Comply with ASTM F 900 for gate posts and single and double swing gate types.

1. Gate Leaf Width: As indicated.
2. Gate Fabric Height: To match fence height.

B. Pipe and Tubing:

1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
2. Gate Posts: Round tubular steel.
3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded or assembled with corner fittings.

D. Hardware:

1. Hinges: 360-degree inward and outward swing as allowed by site conditions
2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate on 14 foot access gate to maintenance area
3. Drop Bars to hold gate leaves open: one per leaf.
4. Closer: Manufacturer's standard.

2.4 CONCRETE MIXTURES FOR FOOTINGS

A. Comply with ACI 301 requirements for concrete mixtures.

B. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301, as follows:

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of slabs to receive troweled finishes to exceed 3 percent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, concrete work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading and installation of concrete perimeter curb is completed unless otherwise permitted by Architect.

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

C. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 100 feet or line of sight between stakes. Indicate locations of utilities, underground structures, benchmarks, and property monuments.

D. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

E. Post Excavation: Drill or hand-excavate holes for posts to diameters indicated on drawings, in firm, undisturbed soil. Spacing between posts not to exceed 10’-0” maximum.

F. 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 above ground portion of posts from concrete splatter.
    a. Concealed Concrete: Top 3 inches below grade as indicated on drawings to allow covering with surface material.
    b. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
    c. Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

G. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of as indicated on Drawings.

H. Line Posts: Space line posts uniformly at 96 inches o.c. or to be spaced equally along overall dimension.

I. Chain-Link Fabric: Apply fabric to outside of enclosing framework.

1. Leave 2 inches between finish grade or surface and bottom selvage unless otherwise indicated.
2. Minimize dimension of selvage above and below rails.
3. Do not install fabric on an angle for sloped fencing. Cut fabric to maintain alignment of non-sloped fencing.

J. 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 and lubricate where necessary.

K. 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.

END OF SECTION 323113

SECTION 323119

DECORATIVE FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative metallic-coated-steel tubular picket fences and gates
2. Decorative aluminum fences and gates
3. Vinyl Board on Board fences and gates.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design decorative fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
1. Provide fencing system including top and bottom rails, single and double swing gates with appropriate cross bracing and post size, post caps, closing and locking hardware.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fence panels and gates. Include plans, elevations, sections, details, hardware and attachments to other work.

C. Samples: For each fence material and for each color specified.

1.4 DELIVERY, STORAGE AND HANDLING

A. Provide manufacturer’s standard limited warranty that its ornamental fence system is free from defects in material and workmanship including cracking, peeling, blistering and corroding for a period of 15 years from the date of purchase.

PART 2 - PRODUCTS

2.1 DECORATIVE METALLIC-COATED-STEEL TUBULAR PICKET FENCES

A. For all football stadium perimeter fences and gates

B. Decorative Metallic-Coated-Steel Tubular Picket Fences: Comply with ASTM F 2408, for light industrial (commercial) application (class) unless otherwise indicated.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Ameristar Fence Products ; Montage Commercial; Majestic 3 rail or comparable product by one of the following:
      a. BetaFence USA LLC.
      b. Master Halco.

C. Height: 8'-0"

D. Post Caps: Formed from steel sheet and hot-dip galvanized after forming .

E. Pickets: Square tubes.

   1. Terminate tops of pickets at top rail for flush top appearance .
   2. Picket Spacing: 4 inches clear, maximum.
   3. Picket size: ¾" square x 14 ga

F. Post : Square tubes
   1. Line post size: 2 1/2:" square x 14 ga
   2. Gate post size: 3" x 12 ga

G. Rails : two top rails and one bottom rail
   1. Rail size: 1 ½" x 1 7/16" channel

H. Metallic-Coated Steel Sheet: Galvanized-steel sheet or aluminum-zinc, alloy-coated steel sheet.

I. Finish: Organic coating complying with requirements in ASTM F 2408 .

2.2 DECORATIVE ALUMINUM FENCES

A. For all site perimeter fences and gates – to match existing fencing behind residences along Route 8.

B. Decorative Aluminum Fences: Fences made from aluminum extrusions.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Ameristar Fence Products; Echelon Plus Majestic ¾ Rail or comparable product by one of the following:
      a. Jerith Manufacturing Company, Inc.
      b. Master Halco.

C. Height: 6'-0"

D. Posts: Square extruded tubes, 2-1/2 by 2-1/2 inches minimum; post size varies per height per manufacturers with 0.093-inch wall thickness.

E. Post Caps: Aluminum castings.

F. Rails: Extruded-aluminum channels, 1-1/2 by 1-7/8” inches, with 0.100-inch- thick sidewalls and 0.070-inch- thick top .

G. Pickets: Extruded-aluminum tubes, 3/4 inch square, with 0.050-inch wall thickness , terminated as indicated.

1. Picket Spacing: 4 inches clear, maximum.

H. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components.

I. Fabrication: Assemble fences into sections by fastening pickets to rails.

J. Finish: Baked enamel or powder coating.
1. Color: Black

2.3 SWING GATES

A. Aluminum Frames and Bracing: Fabricate members from square extruded-aluminum tubes with wall thickness.

B. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

C. Galvanizing: For items other than hardware that are indicated to be galvanized, 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.

D. Aluminum Finish: Baked enamel or powder coating.

2.4 MISCELLANEOUS MATERIALS

A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

2.5 GROUNDING MATERIALS

A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Aluminum.
2. Material on or below Finished Grade: Copper.

B. Grounding Connectors and Grounding Rods: Comply with UL 467.

2.6 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: Black .

2.7 STEEL FINISHES

A. Surface Preparation: Clean surfaces according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

1. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.

B. Powder Coating: Immediately after cleaning, apply two-coat finish consisting of epoxy primer and TGIC polyester topcoat, with a minimum total dry film thickness of not less than 8 mils. Comply with coating manufacturer's written instructions.

1. Color and Gloss: Black .

C. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils per applied coat, to surfaces that are exposed after assembly and installation, and to concealed surfaces.

D. High-Performance Coating: Apply intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

2.8 VINYL BOARD ON BOARD FENCE

A. Basis of Design Product: Subject to compliance with the requirements, provide Hoover Fence Co.; Chesterfield w/ CeraGrain Wood Texture or comparable product

B. Vinyl Fencing and vehicular gate for perimeter fence
   a. Height: 6 feet
   b. Color: Natural Clay
   c. 5” square post
   d. Steel rail channel top and bottom

PART 3 - EXECUTION

3.1 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Post Setting: Set posts in concrete footings 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. Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
3. Space posts uniformly at 8 feet o.c. or as indicated on drawings.

3.2 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.3 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 .

a. 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.

END OF SECTION 323119

SECTION 329200

MEADOW PLANTING

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this Section consists of all labor, materials, equipment, and services necessary for and incidental to the establishment of meadow areas as indicated on the Contract Plans and specified herein. The work includes:
   1. Weed removal
   2. Native grass and wildflower planting
   3. Maintenance

B. Related Sections
   1. Division 32 Section “Planting”

1.2 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity and weed seed and stating certification by a State Board of Agriculture Seed Certification Program. Include the year of production and date of packaging.

B. Qualification Data: For qualified Landscape / Meadow Installer; for licensed Herbicide Applicator.

C. Soil Test Reports: For existing in-place soil.

D. Schedule and methodology for weed removal: provide information on method of weed removal and number of herbicide applications required based on site conditions prior to planting, and coordinated with site availability and overall construction schedule.

E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of meadows during a calendar year. Submit before expiration of required maintenance period.

1.3 QUALITY ASSURANCE

A. Installer shall have not less than 5 years documented successful experience in meadow installations. Installer shall submit evidence of qualifications including photographs, locations and references of owners for review by the Landscape Architect and the Owners Representative.

B. Herbicide Applicator: shall have a commercial State license for herbicide application

C. Quality Control of Seed: Seed lots must be State Certified and blended under the supervision of the Delaware Department of Agriculture, Seed Certification Program Seed or other approved State agency. Seed shall be packed 50 lbs. net weight and packed in new, clean, poly woven bags, tightly woven to prevent leaking and contamination. Each container must have permanently affixed to it an accurate analysis tag, a certification tag, and a project name tag.

D. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

E. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. A minimum of four representative samples shall be taken from varied locations from existing soil, location and depth as directed by Architect.

2. Report suitability of tested soil for meadow grass and wildflower growth.
   a. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide recommendations for corrective action.

1.4 DELIVERY, STORAGE AND HANDLING

A. Seed and other packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, and name and address of manufacturer. Protect seed and other materials from damage and deterioration during delivery and while stored at the project site.

1.5 PROJECT CONDITIONS

A. <u>Planting Time For Native Grasses and Wildflowers</u>: <u>All seeding shall be done only between April 15 to May 30 or September 15 – October 15. If the construction schedule does not allow installation during the specified seeding times, the meadow areas shall be seeded with annual cover crop until the next planting season.</u>

B. 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. No seeding shall be done during windy weather or when the ground is wet or otherwise unsuitable.

C. All areas shall be inspected by the Landscape Installer before starting any work and any defects in existing soil areas shall be reported to the Architect prior to beginning this work. The commencement of work by the Landscape Installer shall indicate his acceptance of the areas to be maintained or planted and he shall assume full responsibility for the work of this Section.

1.6 ACCEPTANCE, WARRANTY AND MAINTENANCE SERVICE

A. At the completion of meadow planting, an inspection of the work shall be conducted by the Architect and Owner's representative for the purpose of initial acceptance. Any outstanding items revealed on inspection and identified on the punch list shall be corrected within two weeks. Initial acceptance will be withheld until those items are completed. Initial acceptance can be on partially completed work.

B. Initial Meadow Maintenance Service: Provide full maintenance by skilled employees of Landscape / Meadow Installer or as directed by the Landscape / Meadow Installer.. Maintain as required in Part 3. Begin maintenance immediately and continue until acceptable meadow is established, for a minimum of **two years** from date of initial acceptance.

C. Warrant in writing that all meadow planting placed on this Project will be in a healthy vigorous condition at the end of the maintenance service period. Warranty shall not include damage or loss of plants due to vandalism, fire, severe winds, extreme cold, or negligence on the Owner's part.

D. Final Inspection and Acceptance: An inspection will be conducted with the Landscape Installer, Architect and Owner's Representative at the end of the two year maintenance period for purposes of Final Acceptance.

E. Owner's maintenance will begin at the end of the required Landscape Installer maintenance period.

F. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Seed: All seed shall be certified and shall be current season crop furnished in sealed standard containers. Seed that has become wet or otherwise damaged will not be acceptable for use. . The aggregate percentage of material, other than specified grass seed in the mixture shall include not more than 18 percent non-viable seed, chaff, hulls, live seed of crop plants (other than those specified), harmless inert matter and weed seed not exceeding 0.50 percent of the total weight of the mixture.

B. Provide the following seed mixtures:

1. Short Grass Meadow and Wildflower mix

Botanical Name	Common Name	Percent
Grasses		
Andropogon glomeratus	Bushy Broomsedge	5
Andropogon ternarius	Splitbeard Broomsedge	5
Eragrostis spectabilis	Purple Lovegrass	5
Festuca brevipila	Hard Fescue	8
Festuca ovina	Sheep Fescue	7
Schizachyrium scoparium	Little Bluestem	30
		60
Forbs		
Asclepias tuberosa	Butterfly Weed	2
Aster pilosus	Heath Aster	1
Aster laevis	Smooth Blue Aster	3
Chaemecrista fasiculata	Partridge Pea	3
Chrysanthemum leucanthemum	Oxeye Daisy	3
Coreopsis lanceolata	Lance-leaved Coreopsis	3
Coreopsis tinctoria	Plains Coreopsis	2
Echinacea purpurea	Purple Coneflower	4
Eupatorium coelistinum	Mistflower	2
Euthamia graminifolia	Narrow-leaved Goldenrod	1
Liatris graminifolia	Narrowleaved Gayfeather	2
Lupinus perennis	Wild Blue Lupine	4
Monarda fistulosa	Wild Bergamot	1
Monarda punctata	Spotted Bergamot	1
Penstemon digitalis	Beardtongue	2
Pycnanthemum virginianum	Virginia Mountain Mint	1
Rudbeckia hirta	Blackeyed Susan	2
Rudbeckia triloba	Browneyed Susan	2
		40

2. Tall Grass Meadow and Wildflower Mix

Botanical Name	Common Name	Percent
Grasses		
Andropogon glomeratus	Bushy Broomsedge	5
Andropogon ternarius	Splitbeard Broomsedge	5
Elymus canadensis	Canada Wild Rye	15
Elymus virginicus	Virginia Wild Rye	15
Schizachyrium scoparium	Little Bluestem	30
Sorghastrum nutans	Indian Grass	5
Tridens flavus	Purpletop	5
		80
Forbs		
Aster pilosus	Heath Aster	1
Aster laevis	Smooth Blue Aster	2
Aster novae-angliae	New England Aster	2

Chrysanthemum leucanthemum	Oxeye Daisy	2
Coreopsis lanceolata	Lance-leaved Coreopsis	1
Coreopsis tinctoria	Plains Coreopsis	1
Desmodium canadense	Showy Ticktrefoil	2
Euthamia graminifolia	Narrow-leaved Goldenrod	1
Heliopsis helianthoides	Oxeye Sunflower	2
Penstemon digitalis	Beardtongue	1
Rudbeckia hirta	Blackeyed Susan	1
Rudbeckia triloba	Browneyed Susan	1
Senna marilandica	Maryland Senna	2
Verbena hastata	Blue Vervain	1
		20

C. Annual cover grass: Incorporate annual cover crop per recommendation of Ernst Seed, alternative supplier, or Landscape / Meadow Installer. If annual cover crop is required for sediment erosion control, coordinate with specifications for SEC seeding.
   1. Summer seeding: Browntop or Italian millet
   2. Spring or fall seeding: Annual oats

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to site preparation operations (herbicide application) the ground surface shall be well drained, cleared of all excess dead weeds, brush, roots, and stones larger than 2 inches in diameter, or any other material which may hinder proper seeding or subsequent maintenance operations.

B. Weed removal: All weeds must be killed prior to planting of meadow grasses. Mow two weeks before herbicide application. Apply glyphosate (Roundup) per manufacturers recommendation, only when plants are actively growing, under appropriate climatic conditions. Application must be done by a licensed spray technician.

C. Based on the extent of weed growth, multiple applications of glyphosate will be required, at a minimum of four weeks apart.

D. Do not till areas being treated with herbicide in preparation for meadow seed planting.

3.2 SEEDING PROCEDURES

A. General: Seeding will be done using an approved native grass drill seeder (Truax brand or equivalent) or other approved methods.

B. Drill seeding: provisions shall be made by markers or other means to assure that successive seeded strips will overlap or be separated by a space not greater than the space between rows planted by the equipment being used. If inspection reveals, during planting operations or after, that strips wider than the space between the rows planted have been left unplanted, or that other areas have been skipped, the Owner’s Representative will require the sowing of additional seed on these areas.

C. Broadcast seeding: Preceed broadcast seeding by scarification of the surface using a drag harrow. Follow the broadcast seeding with two passes with a cultipacker.

D. Hydroseeding will not be allowed for native grass and wildflower seed.

E. When conditions are such, by reason of drought, high winds, excessive moisture, or other factors that satisfactory results are not likely to be obtained, stop the work and resume only when conditions are favorable.

F. Using a drill seeder, drill to a depth of 1/4-inch. Seed shall be drilled twice at half rate - the second drilling shall be performed in a direction perpendicular to the first.

G. Meadow seed shall be applied at the rate 15 bulk pounds per acre.

H. Temporary Seeding: Annual cover crops shall be seeded at a rate of 20-30 lbs per acre based on species and seed suppliers recommendation.

3.3 MAINTENANCE

A. General: The Landscape Installer shall be responsible for the proper care and maintenance of the seeded areas until the completion of the two year maintenance service period and Final Acceptance.

B. Maintenance shall consist of repair and replanting of eroded areas, removal of invasive species and annual weeds, watering if required, reseeding and mowing, as necessary to provide an even, full thick and healthy fixed growth of meadow grass

C. The Landscape Installer shall provide at his own expense protection against trespassing and damage to seeded areas and planted areas until they are accepted. Provide barricades, temporary fencing, signs as required to protect such seeded areas until accepted.

D. The Landscape Installer will not be responsible for damage to meadow plantings due to extreme weather other than drought, acts of vandalism, or other circumstances beyond the Landscape Installers control.

E. Watering: Watering will be required only in case of extreme summer drought conditions.

F. Mowing and weeding; Observation of the desired species growth and weed competition is essential.
   1. First growing season: When undesirable vegetation reaches 12 – 18” tall, mow to no less than 6” high to prevent annual weeds from developing seeds. Mow three times minimum. Spot weed and spot herbicide weeds.
   2. Second growing season: mow one time in early spring to no less than 6 inches high and spot weed and spot herbicide annual weeds.

G. Weed removal: for persistent or noxious weeds, spot application of glyphosate may be required.

H. REPAIR

1. During the maintenance period, all areas and parts of areas which, in the opinion of the Owner's Representative, fail to show a uniform stand of meadow, shall be reseeded, and such areas and parts of areas shall be seeded repeatedly until all areas are covered with a satisfactory growth. Reseeding shall be done at the expense of the Landscape Installer by spreading the seed by an approved method and during an approved season.
2. If the stand is over 60% damaged, or meadow is dominated by invasive weeds, re-establish, following original weed removal, seedbed preparation, and seeding recommendations.

3.4 FINAL ACCEPTANCE

A. Acceptable meadows shall be that which is healthy and vigorous and covering 95 percent of the soil surface in unit increments of 1 square yard with an allowable weed content not to exceed 5 percent.

END OF SECTION

SECTION 329223

LAWNS

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this Section consists of all labor, materials, equipment, and services necessary for and incidental to the establishment of lawn areas as indicated on the Contract Plans and specified herein. The work includes:
   1. Weed removal
   2. Soil amendments
   3. Grass planting (from seed)
   4. Grass planting (sod)
   5. Maintenance

B. Related Sections
   1. Division 32 Section “Planting”
   2. Division 32 Section “Meadow Planting"

1.2 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed, in accordance with the Federal Seed Act, and stating certification by the Delaware State Board of Agriculture Seed Certification Program. Include the year of production and date of packaging.

B. Mulching materials: The Contractor shall provide submittals of manufacturer’s / suppliers specifications for all mulching material.

C. Qualification Data: For qualified landscape Installer.

D. Soil Test Reports: For subgrade, stockpiled onsite topsoil and imported topsoil.

E. Schedule and methodology for weed removal: provide information on method of weed removal and number of herbicide applications required based on site conditions prior to planting.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.3 QUALITY ASSURANCE

A. Installer shall have not less than 5 years documented successful experience in lawn and seeding installations and be a member of the Landscape Contractors Association. Installer shall submit evidence of qualifications including photographs, locations and references of owners for review by the Landscape Architect and the Owners Representative. Installer must exhibit previous successful installations of Bermuda grass turf athletic fields.

B. Quality Control of Seed: Seed lots must be State Certified and blended under the supervision of the Delaware Department of Agriculture, Seed Certification Program Seed. Seed shall be packed 50 lbs. net weight and packed in new, clean, poly woven bags, tightly woven to prevent leaking and contamination. Each container must have permanently affixed to it an accurate analysis tag, a certification tag, and a project name tag.

C. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

D. Soil Analysis: see requirements of Section 329300

1.4 DELIVERY, STORAGE, AND HANDLING

A. Seed and other packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, and name and address of manufacturer. Protect seed and other materials from damage and deterioration during delivery and while stored at the project site.

1.5 PROJECT CONDITIONS

A. Site conditions: All areas shall be inspected by the Contractor before starting any work and any defects in planting areas shall be reported to the Landscape Architect prior to beginning this work. The commencement of work by the Contractor shall indicate his acceptance of the areas to be maintained or planted and he shall assume full responsibility for the work of this Section.

B. 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. No seeding shall be done during windy weather or when the ground is wet or otherwise unsuitable.

C. The Contractor is responsible for the protection of existing structures, utilities, existing plant material and other landscape features during lawn installation.

1.6 MAINTENANCE SERVICE

A. Initial Lawn Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after

each area is planted and continue until acceptable lawn is established, and at least until completion of building construction.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.7 ACCEPTANCE AND WARRANTY

A. At the end of the maintenance period, an inspection of work completed shall be conducted by the Landscape Architect and Owner's Representative for the purpose of initial acceptance. Any outstanding items revealed on inspection and identified on the punch list shall be corrected within two weeks. Initial acceptance shall be withheld until those items are completed. Acceptance can be on partially completed work. Warranty, for a period of one year, shall begin after landscape inspection and initial acceptance.

B. Warrant in writing that all plant material placed on this Project will remain alive and be in healthy vigorous condition for a period of 1 year after completion and initial acceptance of entire project.

C. During the warranty period replace, in accordance with the drawings and specifications, all lawn areas that are in an unhealthy or unsightly condition, or more than 25% dead.

D. Final Inspection and Acceptance: An inspection will be conducted with the Landscape Contractor, Landscape Architect and Owner at the end of the one year warranty period for purposes of Final Acceptance.

E. Warranty shall not include damage or loss of plants due to vandalism, fire, severe winds, extreme cold, or negligence on the Owner's part.

F. Owners Maintenance will begin at the end of the required contractor maintenance period.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Lawn seed species for general lawn areas: State certified seed of grass species as follows:
   1. Provide "Rebel IV" Fescue or equal
      a. 95% tall fescue
      b. 5% Kentucky bluegrass

C. Lawn seed species for practice athletic fields **(ALTERNATE)** and baseball/softball outfields: State certified seed of grass species as follows:
   1. Provide “Riviera” Bermuda grass

D. Lawn sod species for baseball/softball infields: State certified sod of grass species as follows:
   1. Provide “Riviera” Bermuda grass

E. Lawn seed species for practice athletic fields **(BASE BID)** and baseball/softball outfields (annual overseeding only):
   1. Provide annual ryegrass

F. Turf seed mix for bioswales: State certified seed as follows:
   1. Provide Wet Tolerant Seed Mix #14 per DNREC handbook.

G. Mulch:

   1. Mulch shall be clean threshed, straw of oats, wheat barley or rye is acceptable. Mulch shall be free of noxious weeds and seeds. Mulch shall be visually inspected to ensure that it is free from mold, foreign substances, weeds and that it is an air-dry condition suitable for placing with mulch blower equipment.

   2. Tackifier shall be Terra Tack Binders or equal as is manufactured by Grass Growers of Plainfield, New Jersey.

2.2 CHEMICAL AMENDMENTS

A. Rates of all chemical amendment shall be based on soil test and recommendations.

B. Lime: ASTM C 602, Class T, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent, with a minimum 99 percent passing a No. 8 sieve and a minimum 75 percent passing a No. 60 sieve.

   1. Provide lime in the form of dolomitic limestone.

C. Aluminum Sulfate: Commercial grade, unadulterated.

D. Iron Sulfate (Ferris or Ferrous): Shall contain 30-35 percent iron, 35-50 percent sulfur and be supplied by a commercial fertilizer supplier.

E. Sulfate of Potash: Agricultural grade containing 50-53 percent of water soluble potash.

2.4 FERTILIZER

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-form, phosphorous, and potassium in the following composition:

1. Composition: 1 lb. per 1,000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

B. Slow-Release Fertilizer: Granular fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

3. Composition: 10 percent nitrogen, 5 percent phosphorous, and 5 percent potassium, by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive Lawn for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 LAWN PREPARATION

A. Weed removal: All weeds must be removed prior to planting of lawns. Mow closely two weeks before herbicide application. Apply glyphosate (Roundup) per manufacturers recommendation, only when plants are actively growing. Application must be done by a licensed spray technician. Based on the extent of weed growth, multiple applications of glyphosate may be required, at least two weeks apart.

B. Till subgrade to a minimum depth of 3 inches. Remove stones larger than 1-1/2 inches.

C. Spread planting soil to a depth as shown on drawings but not less than required to meet finish grades after light rolling and natural settlement. Mix into subgrade. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1 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.

E. Rake in required lime, fertilizer and soil amendments to a depth of 3” to 4” and rake smooth

F. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.2 SEEDING

A. Do not use wet seed or seed which is moldy or otherwise damaged in transit or storage.

B. Sow seed using a spreader or seeding machine. Do not seed when wind velocity exceeds 5 mile per hour. Distribute seed evenly over entire area by sowing equal quantity in 2 directions at right angles to each other.

C. Sow not less than the quantity of seed specified or scheduled.
   1. Fescue Sowing Rate: Sow grass seed at the following rates: Sow mixture at 9lbs. per 1000 sq. ft.
   2. Bermuda grass Sowing Rate: Sow grass seed at the following rates: Sow mixture at 2-3 lbs. per 1000 sq. ft.

D. Rake seed lightly into top 1/8’ of soil, roll lightly, and water with a fine spray.

E. Protect seeded areas against erosion by spreading specified lawn mulch after completion of seeding operations. Spread uniformly t form a continuous blanket not less than 1-1/2” loose measurement over seeded areas.

F. Water newly planted areas.

3.3 MULCHING

A. Mulch shall be required on all surfaces immediately after seeding.

B. If mulch is displaced before a growth of 1-inch to 1-1/2 inches is obtained, it shall be replaced by the Contractor at no extra expense.

C. Seeded areas shall be mulched with thrashed barley, wheat or oat straw and secured by Terra Tack Binders or equal as is manufactured by Grass Growers of Plainfield, New Jersey.

3.4 MAINTENANCE

A. Maintenance shall consist of repair and replacement of eroded areas, weeding, watering, reseeding and remulching, as necessary to provide an even, full thick and healthy fixed growth of turf grass.

B. The Contractor shall provide at his own expense protection against trespassing and damage to seeded areas and planted areas until they are accepted. Provide barricades, temporary fencing, signs or policing as required to protect such seeded areas until accepted.

C. The Contractor will be responsible for normal tenant, poor weather and other damages to lawns until the time of acceptance by the Owner.
   1. Damages due to circumstances beyond the Contractor's control (i.e., vandalism) will be repaired after requesting a change order and obtaining approval of same.

D. Watering:
   1. First Week: The Contractor shall provide all labor and furnish all watering necessary for establishment of the seed. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary during the first week and in sufficient quantities to maintain moist soil to a depth of at least 4 inches.

2. During growing seasons: The Contractor shall water the lawn as required to maintain adequate moisture in the upper 4 inches of soil necessary for the promotion of deep root growth. New grass must not be allowed to dry out.

3. Water with a fine spray.

E. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow turf-type tall fescue to a height of 2 to 3 inches.
2. Mow turf-type Bermuda grass to the following heights:
   a. Practice athletic fields: 1.5”
   b. Baseball/Softball Infields: ¾”-1”
   c. Baseball/Softball Outlfields: 1.5”-2”

F. 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.

3.5 REPAIR

A. After the grass in seeded areas has appeared, all areas and parts of areas which, in the opinion of the Owner's Representative, fail to show a uniform stand of lawn, for any reason whatsoever, shall be reseeded, and mulched and such areas and parts of areas shall be seeded repeatedly until all areas are covered with a satisfactory growth. Reseeding shall be done at the expense of the Contractor by spreading the seed by an approved method and during an approved season.

B. If stand is over 60% damaged, or lawn is dominated by invasive weeds, re-establish, following original weed removal, seedbed preparation, and seeding recommendations.

3.5 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly seeded areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures after grass establishment period.

END OF SECTION

SECTION 329300

PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this Section consists of all labor, materials, equipment, and services necessary for and incidental to the establishment of tree planting as indicated on the Contract Plans and specified herein. The work includes:
   1. Deciduous and evergreen tree planting
   2. Maintenance

B. Related sections include:
   1. Division 32 Section “Meadow Planting”
   2. Division 32 Section “Lawns”

1.2 SUBMITTALS

A. Submit a list of all nurseries that will supply plants.

B. Qualification Data: For qualified landscape Installer.

C. Soil Test Reports: For existing in-place soil and imported topsoil

D. Submit one-pound samples of all topsoil, organic material, sand and soil additive products in this section. Samples should be labeled to include the location of the source of the material. Samples of all topsoil shall be submitted at the same time as the particle size and physical analysis.

E. Submit the manufactures particle size analysis for all sands and lightweight aggregate if required.

F. Submit the manufactures particle size analysis, pH and certificate of length of composting period for all pine bark and other organic materials.

G. Plant Photographs: Submit color photographs of representative specimens of each type of tree on the plant list. Photos shall be 3”x5” taken from an angle that depicts the size and condition of the typical plant to be furnished. A scale rod or other measuring device shall be included in the photograph. Label each photograph with the plant name, size and name of growing nursery.

H. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall have not less than 5 years documented successful experience in meadow installations and be a member of the Landscape Contractors Association. Installer shall submit evidence of qualifications including photographs, locations and references of owners for review by the Landscape Architect and the Owners Representative.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Sampling and Testing:

1. Provide soil analysis of soil samples taken after rough grading and before placement of topsoil and amendments:
   a. Six samples from turf areas; three to be from athletic field locations
   b. Three samples from planting areas adjacent to building
   c. Three samples from meadow area

2. Provide soil analysis of on-site stockpiled topsoil, imported topsoil and compost.
   a. Three samples from on-site stockpiled topsoil
   b. One sample for each 500 cy of imported topsoil and compost
   c. Provide new samples if soil supplier changes during application.

3. Procedures and Depth of Samples: Per methodology recommended by testing laboratory

4. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.

5. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

D. General: Perform tests on soil samples according to requirements in this article. Report suitability and provide recommendations of tested soil for planting type – turf, planting or meadow.

E. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of 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."

F. 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.

G. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of, 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.
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.

H. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

I. 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. 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. for 6-inch depth of soil.

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. for 6-inch depth of soil.

J. All testing will be at the expense of the Contractor.

K. Plant material observation: Landscape 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. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
1. Notify Landscape Architect two weeks in advance of plant observation / tagging schedule.
2. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.

L. The contractor shall maintain continuously a competent supervisor, satisfactory to the Owner's Representative, with authority to act in all matter pertaining to this work.

M. Conference: Before any work is started a conference shall be held between the Contractor, the Owner's Representative and the Landscape Architect concerning the work under this contract.

N. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

O. It is the Landscape Contractor's responsibility to coordinate and cooperate with the other Contractors to enable work to proceed rapidly and efficiently. Coordinate with all adjacent Contractors' work including all paving, lawn, electrical, etc.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver exterior plants freshly dug.

B. Do not prune trees and shrubs before delivery except as approved by Landscape Architect. Protect bark, branches, and root systems from sun scald, drying, 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 exterior plants during delivery.

C. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants and trees in shade, protect from weather and mechanical damage, and keep roots moist. Plants shall not be stored on site longer than 1 week.

1.5 PROJECT CONDITIONS

A. Plant material should be installed within the following dates: March 1 – July 1 or September 1 – November 15, or as approved by the Landscape Architect. Plant material may not be dug after May 15.

1. If the plants are installed outside of the designated planting season, the contractor is responsible for providing an additional 9 month warranty..

B. 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.

C. Coordination with meadow areas: Plant trees, shrubs and other plants after finish grades are established and before planting meadow areas unless otherwise indicated.
1. When planting trees, shrubs and other plants after planting meadow areas, and promptly repair damage caused by planting operations.

1.6 MAINTENANCE SERVICE

A. Initial Planting Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until completion of building construction and initial acceptance.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.7 ACCEPTANCE AND WARRANTY

A. An inspection of work completed shall be conducted by the Landscape Architect and Owner's Representative for the purpose of initial acceptance. Any outstanding items revealed on inspection and identified on the punch list shall be corrected with two weeks. Initial acceptance shall be withheld until those items are completed. Acceptance can be on partially completed work. Warranty, for a period of one year, shall begin after landscape inspection and initial acceptance.

B. Warrant in writing that all plant material, including groundcovers, placed on this Project will remain alive and be in healthy vigorous condition for a period of 1 year after completion and initial acceptance of entire project.

C. During the warranty period replace, in accordance with the drawings and specifications, all plants that are in an unhealthy or unsightly condition, or more than 25% dead. Warrant all replacement trees for an additional one year period.

D. Final Inspection and Acceptance: An inspection will be conducted with the Landscape Contractor, Landscape Architect and Owner at the end of the one year warranty period for purposes of Final Acceptance.

E. Warranty shall not include damage or loss of plants due to vandalism, fire, severe winds, extreme cold, or negligence on the Owner's part.

F. Owners maintenance shall begin upon initial acceptance of plant material.

PART 2 - PRODUCTS

2.1 TREE MATERIAL

A. General: Furnish nursery-grown trees complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Root balls shall comply with ANSI 260.1 standards and shall meet sizes laid out in the ANSI 260.1 standards as well as being intact and undamaged when they arrive on the site. Trees that have deteriorated root balls will not be accepted.

B. If formal arrangements or consecutive order of trees shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 SHADE TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.

1. Provide balled and burlapped trees.
2. All trees shall have their north side marked in the nursery prior to digging. Set trees in the hole with the marker facing north.

2.3 EVERGREENS

A. Form and Size: Normal-quality, well-balanced, unsheared evergreens, of type, height, spread, and shape required.

2.4 TOPSOIL

A. Topsoil: Utilize existing/ onsite topsoil if deemed suitable. Provide new topsoil that is fertile, friable, natural loam, surface soil, free of subsoil, clay lumps, weeds and other litter, and free of stones and other debris over 1-1/2" and other toxic substances harmful to plant growth. Topsoil shall have a pH range of 5.0 – 7.0.

1. Existing topsoil may require screening to meet the requirements of the specifications. Soil debris can comprise no more than 10% by weight and soil shall exceed a 4.75 mm (No 4) sieve and shall be free of other toxic substances harmful to plant growth.
2. Imported topsoil shall be obtained from an area that has never been stripped.

2.5 PLANT MIX FOR TREE PITS AND SHRUB BEDS

A. Tree Planting Mix: Mix 1/3 topsoil, 1/3 organic material and 1/3 existing soil by volume, based on approval of Landscape Architect. Topsoil to be onsite or imported topsoil. Additional amendments or adjustments to the planting mix to be determined by soil test recommendations.

B. Shrub Planting Mix: Mix 2/3 topsoil and 1/3 organic material by volume. Topsoil to be onsite or imported topsoil. Additional amendments or adjustments to the planting mix are to be determined by soil test recommendations.

C. SOIL AMENDMENTS

1. Lime: ASTM C 602, agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent Applications shall be determined by soil test recommendations to raise pH.
2. Ground sulphur: Applications shall be determined by soil test recommendations to lower pH.
3. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.6 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight. Organic matter to be “Leaf Gro Compost” or approved equal.

2.7 FERTILIZER

A. All fertilizers shall be uniform in composition, free flowing and suitable for application with approved equipment. Applications shall be determined by soil test recommendations.

B. 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.

C. Slow-Release Fertilizer: Granular or pellet fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium.

D. Planting tablets: Tightly compressed chip type, long lasting, slow release, commercial grade planting fertilizer in tablet form.

2.8 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of shredded hardwood. Natural color only.

2.9 STAKES AND GUYS

A. Upright and Guy Stakes: Rough-sawn, sound, new hardwood or pressure-preservative-treated softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch by length indicated, pointed at one end.

B. Guys and Tie Wires: No. 12 gauge galvanized wire.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

B. Lay out plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.2 TREE PIT EXCAVATION

A. Tree Pits: Excavate circular pits with sides sloped inward, as shown on the Drawings. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.
   1. Excavate approximately two times as wide as ball diameter.
   2. 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.
   3. Do not excavate subgrades of adjacent paving, structures, hardscapes or other new or existing improvements.

B. Tree Pits within Paving: Tree pits within paved areas shall be excavated to the extents of surrounding paving and to depth specified.

C. Subsoil and topsoil from excavations may be used as a component of the planting soil upon approval of the Landscape Architect.

D. Notify Landscape Architect if unexpected rock, obstructions or impermeable soils detrimental to trees or shrubs are encountered in excavations. Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

3.3 TREE PLANTING

A. Before 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. Do not use planting stock if root ball is cracked or broken before or during planting operation.

B. Set plants to the elevations shown on the drawings. Place a maximum 2” soil on top of root ball. Set trees on compacted pads as shown. Use plant mix specified to backfill pit approximately 2/3 full. Water thoroughly before installing remainder of the plant mix to top of pit, eliminating all air pockets. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

C. Place planting tablets in each tree planting pit when pit is approximately one half filled, in amounts recommended in soils reports from soil testing laboratory. Place tablets beside the root ball about one inch from root tips.

D. Cut ropes and strings from top of tree root balls after plant has been set. Remove burlap or cloth wrapping from around top half of balls, do not remove from under root balls. Do not turn under and bury any portion of burlap.

E. Smooth planting areas to conform to the grades indicated after full settlement has occurred and mulch has been applied. Thoroughly water plants after mulching.

3.4 TREE PRUNING

A. Prune, thin, and shape trees as only as directed by Landscape Architect.

3.5 SHRUB PLANTING

A. Preparation of planting beds: Excavate entire planting bed to specified depths as shown on Drawings. Till subsurface to a depth of 6 inches. Place planting soil per specified depths, allowing for settlement.

B. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in shrub planting beds.

C. 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.

D. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

E. Balled and Burlapped and container stock: Set each plant plumb with root flare 2 inches above adjacent finish grades.

F. Mulch entire planting bed with mulch. Thoroughly water plants after mulching.

3.6 GUYING AND STAKING

A. Stake trees as shown on drawings.

3.7 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

3.8 MAINTENANCE

A. Contractor is responsible for the following maintenance period by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insets and disease.

1. Maintenance Period: Until completion of building construction and initial acceptance of all plant material.

B. Maintenance between initial acceptance and final acceptance shall be the responsibility of the Owner.

END OF SECTION 02930

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COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

C. Contractor shall perform commissioning tasks which include testing, start-up and adjustments where required per the specifications, local code and manufacturer's instructions. As such commissioning pre-functional and functional test sheets will not be provided by the commissioning agent. The commissioning agent shall witness and review a sample of the specified testing, startup and adjustments. Contractor shall provide the commissioning agent with a copy of any reports associated with specified testing, startup and adjustments.

1.2 REFERENCES

A. Reference Section 230513 for all motors being furnished and/or provided by the Electrical Contractor.

1.3 INSTRUCTIONS AND GENERAL REQUIREMENTS

A. The word "Owner" shall mean Capital School District or their representative on this Project.

B. The word "Contractor" shall mean the Contractors responsible for the Mechanical, Plumbing, Fire Protection and Electrical Work and who shall perform the work as described herein and indicated on the drawing with respect to the trade.

C. The word "Design Professional" or "The Design Professional" shall mean the Architect and/or Engineer.

D. The term "Furnish": shall mean to obtain and supply to the job site. The term "install" shall generally mean to fix in position and connect for use. Where language indicates that one party or trade is to "install" and another is to "connect", the term "install" shall mean only to fix in position, and "connect" shall mean to make final connections to. The term "Provide" shall mean to furnish and install.

E. It is the intent and purpose of these specifications and accompanying drawings to cover and include each item, all materials, machinery, apparatus, and labor necessary to properly install, equip, adjust, and put into perfect operation the respective portions of the installations specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.

F. Any equipment, apparatus, machinery, material and small items not mentioned in detail, and labor not hereinafter specifically mentioned, which may be found necessary to complete or perfect any portion of installation in a substantial manner, and in compliance with the requirements stated, implied or intended in these specifications shall be furnished without extra cost. This shall include all materials, devices or methods peculiar to the machinery, equipment, apparatus, or systems furnished and installed as part of the Electrical work

G. Drawings and specifications have been prepared with best knowledge of conditions available at the time of design. If any obscurities or discrepancies exist, they shall be brought to the attention of the Design Professional before bids are submitted. If they are not discovered before bids are submitted, the Design Professional shall be notified and shall render decision. This decision shall be final.

1. Drawings and Specifications are intended to be complementary; items described or shown in one but not both are to be furnished as if fully shown or described in both locations.

H. The Contractor shall carefully examine all drawings, specifications and contract documents, and the site before submitting his proposal for this work. The Contractor shall compare the site with drawings, specifications and contract documents for all other branches of the work. He shall include in his proposal any monetary sums which he may deem necessary to cover the difficulties and/or costs for furnishing and installing complete all of the work shown on the drawings, the specifications and/or implied therein.

I. It is the intent of the Contract Documents to describe a functionally complete Project to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result will be provided whether or not specifically called for at no additional cost to Owner.

J. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids, except as may be otherwise specifically stated in the Contract Documents.

K. Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to The Design Professional any conflict, error, ambiguity, or discrepancy which Contractor may discover and shall obtain a written interpretation or clarification from The Design Professional before proceeding with any Work affected thereby.

L. If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work or of any standard, specification, manual or code, or of any instruction of any Supplier, Contractor shall promptly report it to The Design Professional in writing.

M. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and The Design Professional, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of The Design Professionals, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible, or by Owner.

N. The Design Professional will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to The Design Professional in writing within 30 days of the event giving rise to the question

O. The Design Professional will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

P. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish The Design Professional the required certificates of inspection or approval.

Q. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and The Design Professional's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and The Design Professional.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall, before submitting his proposal, visit the site of the work and acquaint himself with all conditions relevant to the work and its surroundings. The Contractor shall carefully investigate to determine any variances between actual conditions at site as shown or represented in the specifications or drawings. Anything in the contract documents or any representations, statements, or information made or furnished by The Design Professional notwithstanding, the Contractor shall, regardless of any such conditions relevant to the work, the site of work or its surroundings, assume full and complete responsibility thereof, and all risk in connection therewith at no additional cost to the Owner.

B. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

C. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and The Design Professional except under extraordinary circumstances. The superintendent will be Contractor's representative at the Site and shall have authority to act on behalf of Contractor. All communications given to or received from the superintendent shall be binding on Contractor.

D. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

E. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by The Design Professional, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

F. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

1.5 CODES, RULES, PERMITS, FEES, AND STANDARDS

A. All work described in this specification shall be done in accordance with any applicable Federal, State and Local Codes, Laws, Ordinances, Rules and Regulations governing work of this type.

B. The Contractor shall give all necessary notices, obtain all permits and pay all governmental taxes, fees, deposits and other costs in connection with his work. He shall file all necessary plans, prepare all documents and obtain all required Certificates of Inspection and Approval for his work, including those for occupancy, and deliver same to The Design Professional before request for acceptance and final payment for the work.

C. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus, drawings, in addition to Contract Drawings and Documents in order to comply with all applicable Codes, Laws, Ordinances, Rules and Regulations, whether or not shown on Drawings and/or Specifications.

D. Nothing stated or shown in the Contract Specifications and Drawings is intended to conflict with the above regulations. Should the Contractor find any apparent conflict, it shall be his responsibility to notify the Architect before any work in question is performed or materials purchased.

E. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of The Design Professionals, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work.

F. All materials furnished and all work installed shall comply with the following rules, codes, and standards:

National Electric Code – 2008
All applicable State and Local Codes (ICC 2009) as amended and adopted by the City of Dover.
City of Dover – Public Utilities Department – Electrical.
State of Delaware DTI – Structured Cabling System – Standards and Specifications for Public School; latest edition.
Capital School District Design Standards.
Lighting Power Densities to meet IECC 2009 requirements.
IESNA standard RP-3 and RP-6.
Delaware State Fire Prevention Regulations – 2009
International Fire Code – 2009
NFPA Life Safety Code – 2009
ANSI A117.1-03 - 2003

Recommendations of the Fire Insurance Rating Organization having jurisdiction.
Requirements of all government departments and agencies having jurisdiction.

G. All package equipment shall be independently third party labeled as a system for its intended use by a nationally recognized testing laboratory in accordance with OSHA 29CFR 1910, NEC, and NFPA.

1.6 ABBREVIATIONS

A. The following is a description of the abbreviations used herein:

AC	Alternating Current
ACRMA	Air conditioning & Refrigerating Machinery Assoc., Inc.
AIEE	American Institute of Electrical Engineers
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating & Air Conditioning Engineers
ASA	American Standards Association
ASTM	American Society of Testing Materials
AWG	American Wire Gauge Size
IEEE	Institute of Electrical and Electronic Engineers
IPCEA	Insulated Power Cable Engineers Association
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NFC	National Fire Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

OSHA	Occupational Safety and Health Association
U.L.	Underwriters' Laboratories, Inc.
IBC	International Building Code
IMC	International Mechanical Code
IFC	International Fire Code

B. Refer to the drawings for other symbols and abbreviations.

1.7 WORKMANSHIP

A. All work under this Contract shall be properly coordinated with the work of all trades and separate Contractors with which it comes in contact.

B. All work under this Contract shall be installed in a first-class, neat and workmanlike manner satisfactory to The Design Professional by experienced and skilled mechanics of the trade involved.

1.8 OPERATING INSTRUCTIONS

A. Provide to the Owner three bound copies of compete written instruction on the operation, care and maintenance of each piece of equipment and the installation as a whole. Include frequency of inspection, cleaning and adjusting and other attention as may be required in accordance with manufacturer's instructions. Material shall be manufacturer's brochures, catalog cuts, parts lists, wiring diagrams, etc. Also supply Owner's with three complete sets of approved shop drawings.

B. Furnish qualified personnel to instruct the Owner's personnel in the maintenance and operation of all equipment and systems. Instructing personnel shall remain on the job continuously during working hours until such instruction is complete, but not less than 40 hours.

C. A video recording in digital format (DVD) of the operator training session shall be made during this training period and the DVD submitted to the Owner with the operation and maintenance manuals.

1.9 CORRECTION OF WORK AFTER FINAL PAYMENT AND GUARANTEE

A. Comply as applicable with Section 01 20 00 – Price and Payment Procedures.

B. Final payment shall not relieve the Contractor of responsibility for faulty equipment, materials and workmanship and unless otherwise specified he shall remedy any defects due thereto and pay for damage to other work resulting therefore, which shall appear within a period of one (1) year from the date of acceptance.

C. Include guarantees by the respective equipment manufacturers which shall be subject to the terms and time limits defined under this section.

D. Guarantees furnished by Subcontractor and/or equipment manufacturers shall be counter-signed by the related Prime Contractor for joint and/or individual responsibility for subject item.

E. Manufacturer's equipment guarantees or warranties extending beyond the guarantee period described herein shall be transferred to the Owner along with the Contractor's guarantees.

1.10 SUPERINTENDENCE

A. The Contractor shall give his personal superintendence to the work or shall have a competent superintendent, satisfactory to The Design Professional, and the Owner, present at all times during construction with authority to act for him. The Contractor shall also provide an adequate staff for the proper installation, coordination and expediting of his work.

1.11 SCAFFOLDING, RIGGING, HOISTING

A. The Contractor shall furnish all scaffolding, staging, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished or installed by him and shall remove same from premises when no longer required.

B. Scaffolding and staging construction and maintenance shall be in strict accordance with all applicable codes and regulations including Contractor's safety regulations. The structure shall be erected so as not to interfere with the work of others. If it becomes necessary to move the scaffolding and/or staging to permit installation of other work, the Contractor shall do so at his own expense.

C. Scaffolding, staging and hoisting equipment shall not be supported from piping, conduits or other equipment.

1.12 ROOF PROTECTION

A. Provide adequate roof protection during the construction phase and remove same after the work is completed. Any damage to the roof surface will be repaired at the expense of the Contractor.

1.13 SUPPORT STEEL AND MISCELLANEOUS WORK

A. The Contractor shall provide all necessary miscellaneous steel required for the installation and support of the work under this contract. Work shall include but not be limited to conduit supports, equipment supports, gratings, handrails, transformers, etc. Perform all rigging required to set the equipment in place.

B. Unless otherwise indicated, all structural steel shall be ASTM-A36 with hot dipped galvanized finish. Welds shall be finished with (2) coats of zinc rich paint.

1.14 AS-BUILT DRAWINGS

A. The Contractor shall keep on the job a separate set of drawings on which he shall make a record of any changes in location, size or other details or installation not covered by supplemental or detail drawings. Such records shall be made at the time the changes in the work are made so that at any time the marked drawings indicate the true condition of the work. He shall record the exact dimensioned locations, grades, elevations and sizes of all underground and under floor slab conduit and piping. Dimensions shall be distance from columns, finished building surfaces, curbs and finished grade lines. At the completion of the work the marked drawings shall be transferred

to AutoCAD 2005 (or later) drawings and the drawing files shall be forwarded to The Design Professional.

1.15 PAINTING

A. Generally all painting shall be performed by this Contractor unless otherwise indicated.

B. The Electrical Contractor shall be responsible for painting all color coded junction boxes.

1.16 GUARANTEE

A. All equipment and components of all systems furnished under this Contract shall be guaranteed to perform trouble free for a period of one year from the date of final acceptance of installation by The Design Professional. Any equipment that has been in operation prior to the date of acceptance shall also be guaranteed to be free of defects and perform without failures for a period of one year after the date of final acceptance. Any corrections and adjustments to the systems, replacement of equipment or parts during the guarantee period shall be furnished by the Contractor, at no additional cost to Owner.

B. During the one (1) year guaranty period the Contractor shall make a minimum of two (2) visits to the site (6 months after acceptance and immediately prior to the end of the guarantee period). During each visit, the Contractor shall thoroughly check all equipment for proper operation. Reports shall be generated and forwarded to the Owner describing the systems inspected, date of inspection, and status of equipment.

1.17 SCHEDULING OF WORK

A. The scheduling of any work affecting existing installations or facilities, shall be coordinated with the Owners' representative. Shut-down of utilities or equipment affecting operations of any existing part of the building will not be permitted except as provided below. Any premium time or additional cost to comply shall be at the expense of the Contractor and considered to be included in his bid. Shut-down of any operating facility or services including plumbing, fire protection, refrigeration, heating, air conditioning, electrical, or other installations shall be preceded by a written request at least seven calendar days prior to the shut-down.

B. All required shut-downs unless otherwise instructed, shall be during nights, holidays, or on weekends. Any tests which are to be carried out on the building facilities and any connections to be made in the building facility which would involve a change in the system or liability to the system or involve a shut-down in light or power, the Contractor shall not proceed with such operations until he has received written permission from the Owner.

C. Other Contractors will be performing work in the complex simultaneously while this Contractor is engaged to do work. The Contractor, in addition to coordinating with the Owner, shall coordinate and schedule shutdown of utilities, fire alarm, or equipment with the other Contractors. Should the failure of this Contractor to coordinate or notify the other Contractors of the shutdown of utilities cause a monetary burden on the other Contractors, this Contractor shall compensate the other Contractor’s for their reasonable monetary loss.

1.18 CONCURRENT WORK BY THE OWNER

A. The Owner reserves the right to have other Contractors perform work in other areas of the Complex simultaneously while this Contractor is engaged to do work. This Contractor and his personnel shall cooperate and coordinate the work to be performed with all other Contractors with who he comes in contact. In no way shall this Contractor interfere with the progress of the work.

1.19 CONSTRUCTION ELECTRICITY

A. Electrical power for lighting and operation of construction power tools by all trades shall be provided by Contractor from local utility or Contractor's on site generator. Contractor shall provide all safety devices, extension cords, and remote outlets as required by regulations and use. All construction electric power shall be GFCI protected.

B. Temporary lighting and wiring shall be provided by the Contractor as required by OSHA and be removed upon finishing the work.

PART 2 MATERIALS AND EQUIPMENT

2.1 GENERAL

A. All installed materials and equipment shall be new and the best of their kind and shall conform to the grade, quality and standards specified herein in every detail.

B. Unless otherwise specifically stated, all materials and equipment offered under these specifications shall be limited to products regularly produced and recommended by the manufacturer for the service intended. This material and equipment shall have capacities and ratings sufficient to amply meet the requirements of the project. The capacities and ratings shall be in accord with the Design Professional’s data or other comprehensive literature made available to the public by the manufacturer and in effect at the time of opening bids.

C. Equipment shall be installed in accordance with manufacturer’s instructions for type and quality of each piece of equipment used. These instructions shall be obtained from the manufacturer and shall be considered part of these specifications. Type, capacity and application of equipment shall be guaranteed suitable to operate satisfactory. No experimental material or equipment shall be permitted.

D. All equipment, material and devices for which a label service is available shall bear the label of the Underwriters Laboratory, Inc. (UL).

2.2 EXCAVATION AND BACKFILL

A. Perform all excavating and backfill necessary for work under this Contract. Comply as required with Division 31 – Earthwork. It is assumed that all excavation under this Contract will be soil excavation. In event that rock is encountered, the Contractor shall be compensated for rock excavation in accordance with the unit prices or soil and rock excavation. Bidder shall state in his proposal, the unit prices for soil and rock excavation and the unit prices for soil excavation to be omitted. Rock excavation shall consist of solid rock or boulders over two cubic yards in volume

or other material which can only be removed by line drilling or chipping by power equipment; blasting will not be permitted. In event rock is encountered notify the Design Professional of its existence in the areas not to be excavated and accurate measurements of the extent of the rock actually removed shall be made and submitted to the Design Professional.

B. To protect persons from injury, and to avoid property damage, adequate barricade, construction signs, torches, lanterns, and guards shall be placed and maintained during the progress of the construction work and unit it is safe for traffic use. Rules and regulations of local authorities respecting safety provisions shall be observed.

C. The excavation may be accomplished by machine to within 2 inches of the subgrade elevation. The excavation shall be completed by hand to neat lines.

D. Trenches shall be instrument graded using batter board and flow line and of sufficient width to provide a free working space of not less than 24 in. width and not greater than 12 in. on each side of the conduit, whichever is greater. Trenches shall also be wide enough to thoroughly ram the backfilling around the conduit and to secure a firm bed.

E. In earth excavation, the trench shall be carried to the invert of the conduit. Where rock excavation is encountered, the trench shall be carried to a point 6 in. below the construction. No construction shall be bedded directly upon rock, but shall be cushioned by a 6 in. layer of selected crushed stone or gravel.

F. Where material is removed below the grade of the bottom of a structure it shall be replaced with concrete of the same quality as the concrete in the structure. Where material is removed below the grade of a conduit trench it shall be replaced with a lean concrete mix. Make no excavation to depth below a line of slope one ft. rise on 2 ft. length from such excavation to bottom of footing on other construction.

G. Any conduit that is run in unstable ground shall be supported on 5'-0" centers with concrete or brick piers. These piers shall be not less than 12 inches square and must reset on solid ground. Brick piers shall be laid in cement mortar.

H. Maintain banks at all times by means of shoring and bracing to avoid cave-in and make good any damage done to property or work of others due to failure to properly shore any excavation. Shoring done shall be removed after installation and test of systems have been approved. Material for shoring shall be placed in accordance with the regulations of the Department of Labor and Industry.

I. All excavations shall be left open until reviewed by the Design Professional. After the work has been installed, tested, inspected, the excavation shall be backfilled with the best carefully selected materials free from stones, large pebbles, hard lumps on frozen earth. Trenches shall not be backfilled until the work has been reviewed by the Design Professional. All backfill shall be made in 8 in. layers. The first 2 layers shall be fine earth, hand-tamped. The remainder of the fill over new construction to the surface shall be ordinary approved excavated material placed in 8 in. layers and thoroughly compacted to not less than 90% of maximum Modified Density as determined by ASTM D 1557-70. No water soaking will be permitted. All excess materials shall be disposed of as directed. Seeding shall be by the General Contractor.

J. Where excavation is required under existing walkways and roadways, surface shall be restored with new materials equivalent to the material originally used. Whole cement pavement blocks shall be removed and replaced; removal and repair of partial blocks is not permitted.

2.3 PUMPING

A. Provide pumping equipment to pump all water to prevent it from collecting in trenches, basement areas, and any other excavations necessary to carry out contract requirements. Prepare run-off trenches as required to pump water into and use surplus earth to form dam at top of excavation to run back surface water.

B. Comply as applicable with Section 31 21 19 – Dewatering.

2.4 CHASES AND OPENINGS

A. Provide information to the appropriate trades regarding size and location of all openings and chases as required for the installation of this electrical Work.

2.5 CUTTING AND PATCHING

A. Provide all cutting and patching required for work performed under this Contract. Comply as applicable with Division 09 – Finishes. No holes may be cut or drilled in structural members without prior approval of Owner's Representative. Cutting shall be done by mechanics skilled in their respective trades.

B. No cutting that may impair the strength of the building construction shall be done. No holes may be drilled in or attachments welded to the beams or other structural members without prior approval from the Owner's Representative. All work shall be done by mechanics skilled in their trade.

C. All patching shall be done in a manner to match appearances and quality of existing surfaces.

D. Provide sleeves for conduits, raceways, and cables passing through poured concrete decks, footings, walls, etc. Cut all openings for conduit passing through precast concrete or existing concrete masonry. Such holes shall be cut with core drill or similar equipment. They shall not be cut with hammer or chisel, or with any power tool depending on impact for its cutting power.

E. For holes and openings in pre-cast concrete, 2-1/2 inch round and above, or 2-1/2 inch and above on longest side, prepare a drawing for the Design Professional's review for same to be pre-cast in the factory; for holes and openings smaller than above, prepare a drawing for the Design Professional's review for same to be cut, cored or drilled in the electrical trade.

F. All cutting and patching shall be performed by the Contractor. All holes shall be core bored. All floors, blacktop, walks, curbs, etc. shall be saw cut.

G. The Contractor shall prepare required openings fir ductwork, piping, conduit, and all other work required for the installation of the equipment and systems installed.

H. Unless otherwise indicated, the Contractor shall patch and seal all walls, floors, ceilings (drywall, plaster, lay-in, etc.) soffits, etc. where existing items such as conduit, raceways, hangers, supports, etc. Are removed or new work is installed under this contract. All patching shall be performed with equivalent materials and finishes and shall match adjoining surfaces in both texture and finish.

I. Remove and replace existing ceiling system tiles and grids as required to install the new work. Repair as necessary and use new grids and tiles to match the existing.

J. The contractor shall properly set all sleeves required for his work described under this section during construction.

K. Where sleeves and openings are not installed or are incorrectly sized or located as a result of Contractor's failure to furnish verifying drawings or set sleeves in sufficient time so as not to delay construction, all cutting and patching shall be done by the respective Contractor in a manner of satisfactory to the Design Professional and all costs are borne by the Contractor.

N. Conceal conduit in all finished locations. Cut and patch existing ceilings, walls, and structural members where necessary for concealment.

2.6 CONCRETE

A. Provide concrete work required for work performed under this Contract. Comply as applicable to Division 03 – Concrete.

B. Concrete shall have a minimum of 28-day compressive strength of 4000 lbs. per square inch. Forms shall be lined with tempered hard board, properly braced so that finished surfaces are smooth and true to line dimension. Corners shall be chamfered 1-inch. Foundation bolts shall be built into the concrete and where depth permits and shall be set in iron pipe sleeves for adjustability. The Contractor shall furnish all required foundation bolts, washers, sleeves, plates, templates, etc., for all mechanical and electrical equipment. Conduits for pad mounted motors shall be installed within the pad area. The Contractor shall coordinate with the Electrical work and shall size equipment pads accordingly to receive electrical conduit.

C. Placing of reinforcing steel and concrete shall be done according to the recommendations of the American Concrete Institute and Concrete Reinforcing Steel Institute, and all materials shall conform to American Society for Testing Materials Specifications, applicable to this work. Equipment pads shall be properly dowelled in with floor construction, and shall have sloped bevels on all horizontal and vertical edges.

D. Form work shall be of sufficient strength to maintain desired shape during pouring of concrete and tight enough to prevent leakage of the grout through joints.

E. Submit shop drawings for approval showing dimensions, reinforcing and dowelling.

F. Provide at the time of pouring concrete, all necessary anchor bolts. Anchor bolts shall be the hook type, of proper size and length to suit the equipment. Anchor bolts shall be set in pipe sleeves of approximately twice the bolt diameter and one half the embedded length of the bolt. Assume full responsibility for proper emplacement of the bolts.

G. Drop-in wedge anchor bolts or self-drilling anchors may be used in place of hook bolts. Minimum embedment in concrete of wedge anchor bolts shall be in accordance with manufacturer's instructions. Wedge anchor bolts shall be manufacturer by Phillips Drill Co. or USM Corp. Self-drilling anchors shall be manufactured by Phillips Drill Co.

H. After equipment is set in place and bolted down, any space between equipment base and floor slab or foundation shall be completely filled with non-shrink grout equal to Master Builders Co., Ltd. Embeco 153 grout.

I. Provide reinforced concrete pads under all mechanical, plumbing, fire protection, and electrical equipment.

J. Concrete pads under equipment unless otherwise indicated shall be a minimum of 4” height, six inches beyond equipment on all sides, and in all cases not less than what is indicated on drawings. Concrete pads shall be reinforced with 4” x 4” wire mesh, No. 6 gauge. Concrete pads shall be properly bonded and dowelled to the floor slabs.

2.7 DEVICE BOXES

A. Provide for each device indicated, a box suited to the purpose for which the device is to be put and to the location in which it occurs.

B. Concealed device boxes shall be pressed steel, not less than 4" square, and 1½" deep, zinc-coated and provided with the proper size knockouts for the conduits to be used. All unused knockouts shall remain closed. Boxes in concrete slabs shall not be less than 2" deep. Boxes in finished plaster surfaces shall be provided with suitable approved plaster covers. Cast boxes with threaded hubs shall be used for all surface mounted switches, receptacles, etc. Use minimum 2½” deep masonry box for 4” block and minimum 3½” deep masonry box for 6” and 8” block.

C. Do not install device boxes back to back.

D. Coordinate with Design Professional prior to installation for all device mounting heights.

E. Secure electrical devices firmly in place within boxes, setting devices straight and true with box sides and mounting surface.

F. Install face plate straight and true with mounting surface.

1. Gaps between back of plate and mounting surface are not permitted.

2. Set face plate mounting screws with slots in vertical direction.

G. All backboxes recessed in concrete or CMU masonry walls shall sit flush with face of wall. Provide boxes with proper depth and/or extension ring.

H. Wiring devices to be furnished and installed by this Contractor shall consist of the various types of wall switches, receptacles, outlets, and plates as required for the Electrical Work. The extent of the wiring devices shall be shown on the drawings.

I. Local wall switches near doors shall be located on the strike side of doors as finally hung, whether or not so indicated on the Plans. If, because of the construction, it is not practical to mount on the strike side, these locations shall be brought to the Design Professional's attention, and meet his approval before roughing in.

J. Single pole switches shall switch the ungrounded wire of circuits. Neutral wire shall not run through switches provided with a neutral shunt or bridge.

K. Switches shall be mounted with the long dimensions vertical.

L. For each voice, data, voice/data, CATV, and audio outlet shown, provide a 4" square by 2-1/8" deep box with conduit and pull wire turned out above an accessible ceiling space unless otherwise noted.

M. All receptacles and communication outlets located next to each other shall be mounted 8" apart (horizontally) center to center.

N. All communication outlets located adjacent to each other shall be ganged under single cover plate.

O. All switches located adjacent to each other shall be ganged under single multi-gang cover plate.

2.8 JUNCTION AND PULLBOXES

A. Provide junction and pullboxes in conduit and EMT runs as shown or as required. These shall be of code gauge galvanized steel, riveted or welded construction, reinforced as necessary for rigidity during and after installation, and with proper flanges to receive the covers, unless otherwise indicated.

B. Boxes shall be not less than sizes required by Article 314 of National Electrical Code or as shown on Drawings, and large enough to accommodate wiring without sharp bends in conductors or excessive bearing of wires against covers.

C. In vertical runs of conduit provide a NEC sized junction box with cable support bushing and insulating wedges spaced not greater than the values given in NFPA 70 Table 300-19 (a) unless otherwise noted. If wedges do not adequately support cable, in addition, provide cable clamps.

D. Rigid conduit connections shall be secured in place by double locknuts and insulated bushings.

2.9 HANGERS AND SUPPORTS

A. Reference Section 260529 for additional requirements.

B. Runs of exposed conduit and EMT shall be supported from approved individual pipe hangers spaced in accordance with the National Electric Code. Hangers shall be approved as electrical raceway support devices. Caddy fasteners will not be accepted.

C. Hanger rods shall be supported from approved malleable iron inserts, imbedded in the concrete floor slabs at the time the floor slabs are poured, approved anchor at attachment C-type malleable iron clamps, or from unistrut support system.

D. All materials and equipment installed by the CONTRACTOR shall be firmly supported and secured by the construction. Where necessary, anchors shall be non-hydrophobic and shall be inserted in holes drilled in the construction in accordance with the manufacturer's instructions.

E. Raceways, boxes, etc. shall be supported directly from structure, independent of ceiling grid system, duct, piping or other work. Provide unistrut framing, as required, to clear interferences from the other trades,

F. Conduits and EMT shall be securely and independently supported so that strain will not be transmitted to outlet box and pullbox supports, etc. Supports shall be rigid enough to prevent distortion of conduits during wire pulling.

2.10 WIRING DEVICES

A. Wall Switches

1. Switches for the local control of lighting shall be of the extra heavy duty specification grade, quiet toggle type.

B. Receptacles

1. Receptacles for convenience outlets shall be extra heavy duty specification grade grounding duplex, parallel slot, self-aligning type.

C. Special Purpose Outlets

1. Where shown on the drawings, provide special purpose extra heavy duty specification grade outlets of the ampere capacity, voltage, and NEMA configuration indicated.

D. Wall Plates

1. Unless otherwise specified, all wall plates for switch, receptacle, and similar outlets shall be brushed stainless steel with beveled edges to lie flat against the wall. Where more than one switch or outlet occurs at one point, gang plates shall be used.

2. Weatherproof receptacles shall have horizontal metal weather protective covers equal to Mulberry #30451Z (bronze). Provide weatherproof “While-In-Use” covers where indicated and for all sump sumps.

3. Weatherproof switches shall have cast metal lever type cover plates.

E. All devices shall be recessed, unless otherwise noted. Contractor shall cut and patch existing structure to recess all devices, conduit, and wiring in finished areas.

2.11 ELECTRICAL IDENTIFICATION PRODUCTS

A. Adhesive Marking Labels for Raceway and Metal-clad Cable: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service (Emergency, Lighting, Power, Light, Power D.C., Air Conditioning, Communications, Control, Fire).

1. Label Size: As follows:

a. Raceways 1-inch and smaller: 1-1/8 inches high by 4 inches long.

b. Raceways larger than 1-inch: 1-1/8 inches by 8 inches long.

2. Color: Black legend on orange background.

B. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

C. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field-printed legends to suit the application. Orange background, except as otherwise indicated, with Eyelet for fastener.

D. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners.

E. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.

F. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, preprinted cellulose acetate butyrate signs with 20-gauge, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4-inch grommets in corners for mounting.

G. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

H. Pressure sensitive industrial tape with adhesive backing and Helvetica lettering. The lettering shall be applied with a Kroy high performance labeling machine or equal. Tape shall be clear with black lettering.

2.12 SUBSTITUTIONS

A. Comply as applicable with Section 01 60 00 – Product Requirements or as indicated in each product specification. Equipment may be shown or specified in several ways:

B. Equipment may be shown or specified in several ways:

1. Manufacturer and catalogue or model number with the words "no substitutions," "no equal," "(manufacturer) only," or words of similar respect. Contractor shall furnish the specified item.

2. Several manufacturers and model numbers listed; or one manufacturer and model number, followed by "equals by (mfr A), (mfr B), (mfr C)," or words of similar respect.

a. If one of the manufacturers is listed on the drawings, that manufacturer shall be considered the basis of design. If none is so listed, the first manufacturer named in the Specification shall be considered the basis of design.

b. Where manufacturer's or supplier's name, style and catalog numbers are mentioned in the description of material and equipment in the specifications or on the drawings, it is to be understood that they are for the purpose of setting a standard.

c. If Contractor elects to furnish equipment other than the basis of design, he shall verify capacities, physical size, weight, HVAC requirements, methods of connection to other parts of the system, and all other relevant data. Contractor shall be responsible for informing the Design Professional of all changes required to other equipment, spaces, structure or systems in order to install the substituted equipment. He shall furnish all required shop drawings or sketches required for Design Professional to evaluate the required changes, and shall be responsible for all costs associated with such changes, including costs of design or engineering, if such are necessary, and costs of other trades.

3. Where manufacturer's or supplier's names are listed in conjunction with the manufacturer or supplier that is basis of design, they are given to approve the firm name only. Equipment or material submitted by such firms must meet the detailed technical specifications written for the respective item. Contractor shall be responsible for verifying capacities, physical sizes, weights, HVAC requirements, and methods of connection to other parts of the system, etc. Contractor shall furnish all required shop drawings for equipment, and for its connection and installation.

C. If any substituted items are submitted after contracts have been awarded, and there is any question of equality of such items, samples may be required to be submitted both for the item specified and that to be substituted, or, further proof of equality may be required to the entire satisfaction of the Design Professional. In no case shall additional remuneration be allowed because of the rejection of a substitute.

D. When the equipment is relocated to a place other than that shown on the drawings, or when equipment other than that specified is used, the Contractor shall pay the extra cost of required revisions such as structural steel, concrete, HVAC, piping, etc.

E. The Design Professional's costs to evaluate substitutions and to revise Drawings and Specifications because of substitutions will be paid by the Contractor.

2.13 SHOP DRAWINGS

A. Refer also to Division 00, 01 and other Division 26, 27, and 28 sections.

B. Furnish shop drawings, catalog cuts, performance data and other required data to the Design Professional for review for all material and equipment specified hereinafter. Sufficient data shall be submitted to show compliance with the requirements of the plans and specifications. All shop drawings submitted shall be first checked and corrected before submitting for approval. Approval for shop drawings by the Design Professional will not relieve the Contractor from responsibility for errors or omissions therein. All such errors or omissions must be made good by the Contractor irrespective of any approval by the Design Professional.

C. On submissions beyond the initial one, clearly identify changes made from the initial submittal other than those requested by the Design Professional. The Design Professional will review only those changes he requested and those identified by the Contractor.

D. Shop drawings required shall include, but not necessarily be limited to, the following:

1. Shop drawings, cuts and catalogue information showing appearance, dimensions, performance, weight, etc., of all equipment, appurtenances, etc.
2. Schedules of all materials showing type and manufacturer.
3. Wiring diagrams and schematics for equipment.
4. All special equipment and systems.
5. Any special constructions.
6. Other shop drawings as may be requested.

E. Digital files of Electrical work will not be provided for the purpose of shop drawing preparation. Digital files of architectural plans, elevations, sections, etc. may be available for background purposes; it is the responsibility of the Contractor to confirm availability prior to bid.

F. Facsimile submission of shop drawings will not be accepted as the submittal format. An advanced copy for starting the process may be faxed but hard copy submittals are to be submitted for actual review.

G. Electronic submission of shop drawings shall be permitted in the format as noted elsewhere in the specifications.

H. Shop drawings shall be submitted in a timely manner, taking due account of time requirements for processing, correcting and distributing the shop drawings to all persons or trades requiring the information, as well as time required for manufacture of the equipment. Design Professional will not be responsible for construction delays resulting from late submission of shop drawings, nor for delays caused by the need to correct and resubmit shop drawings which were not correct, which involved substituted equipment, or otherwise required review, correction and resubmission.

I. If Contractor elects to proceed to install equipment for which approved Shop Drawings have not been received, he does so at his own risk; Design Professional is not obligated to accept such equipment or work, nor will Design Professional be liable for claimed costs or delays required by correction of such work.

2.14 FLASHING AND ROOFING WORK

A. Comply as applicable to Division 07 – Thermal and Moisture Protection.

B. The Contractor shall perform all cutting, patching and sealing of roofs as required for the installation of all work under this Contract.

C. The contractor bears the complete responsibility for maintaining and obtaining the watertight integrity of the affected areas of the roofs both during and after the completion of construction.

D. The Contractor shall provide all base flashings, counter flashings, and hot applied roofing materials necessary to properly flash and seal the roofs as required and to prevent any water or moisture leakage whatsoever from occurring as a result of this work.

E. Unless noted otherwise, all flashings shall be minimum 24 gauge galvanized steel. Base flashings shall have minimum 4" roof flanges on all sides. Flanges of all base flashings shall be secured and stripped into existing roofing in accordance with the best practices and methods of the roofing trade for a watertight installation.

F. All joints and seams of all flashings shall be continuously soldered.

G. After installation, all exposed metal surfaces of base flashings shall be given two (2) applications of roofing coating.

H. All roofing work shall be performed by first class mechanics experienced in the roofing trade.

I. Contractor must exercise extreme care so as not to damage existing roofs while working thereon and he shall provide protection planking and plywood as required to achieve this result. Any damage to the existing roofs and their watertight integrity caused as a result of work being performed under this Contract shall be properly repaired by the Contractor to the satisfaction of and at no cost to the Owner.

PART 3 EXECUTION

3.1 VISIT THE SITE

A. Before submitting bid, visit the site of the work and be thoroughly familiarized with the conditions affecting the work. No extra payment will be allowed on account of extra work made necessary by failure to do so.

3.2 WORKMANSHIP

A. All work shall be installed in a first class, neat and workmanlike manner by mechanics skilled in the trade involved. All details of the installation shall be mechanically correct. Should the Design Professional direct removal, change, or installation of any equipments or systems not installed in a neat and workmanlike manner, such changes shall be made by the Electrical Contractor at no expense to the Owner.

B. Equipment shall be installed in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment used. The Contractor shall obtain these instructions from the manufacturer and these instructions shall be considered part of these specifications. Type, capacity, and all applications shall be suitable and shall operate satisfactorily for the purpose intended for the system.

C. Drawings are generally indicative of the work to be installed, but do not indicate all bends, offsets, fittings, junction / pull boxes, hand holes and specialties which may be required, or the exact locations of all conduit. Contractor shall investigate structure and finish conditions affecting his work and arrange his work accordingly; furnishing such items as may be required to meet such conditions. Contractor is responsible for exercising proper judgment to arrange his work and materials so as to avoid interference with other trades.

1. Riser diagrams and schematics generally indicate equipment to be used in various systems involved. This information may or may not be duplicated on the plans, but equipment shown on either plans or riser diagrams and schematics shall be provided as if shown on both.
2. All grades, elevations, dimensions and clearances of equipment shown on drawings are approximate and shall be verified at site.
3. Where work or equipment is referred to in singular terms, such reference shall be deemed to apply to as many items of work or equipment as required to complete entire installation.

D. All materials and equipment shall be new and shall conform to the grade, quality, and standards specified herein in every detail.

E. All materials and equipment shall be made in the USA.

F. All equipment offered under these specifications shall be limited to products regularly produced and recommended for the specified service. Ratings shall be in accordance with the Design Professional's data or other comprehensive literature made available to the public and in effect at this time.

3.3 LINES AND GRADES

A. Layout work and establish heights and grades for work in strict accordance with the intent expressed by the drawings and all the physical conditions at the building and be responsible for the accuracy of same.

3.4 FIELD MEASUREMENTS

A. Before ordering any material or doing any work, verify all measurements at the building and site and be responsible for the correctness of same. No extra compensation will be allowed on account of differences between actual dimensions and measurements and those indicated on the drawings. Any difference which may be found shall be submitted to the Design Professional for consideration before proceeding any further with the work.

3.5 DELIVERY OF EQUIPMENT

A. Be responsible for delivery of equipment, unload and store in a manner not to interfere with the operation of other trades. Additional expense incurred because of equipment or material delivery delays shall be assumed by the responsible Contractor.

3.6 PROTECTION OF WORK

A. All work, equipment and materials shall be protected at all times.

B. All raceway openings shall be closed with caps or plugs during installation. All equipment shall be tightly covered and protected against dirt, water, plaster, paint and other foreign material or mechanical injury during entire progress of installation. Make good all damage caused either directly or indirectly by workmen employed to fulfill requirements of the Electrical Work.

3.7 REMOVAL OF RUBBISH

A. During the course of construction, periodically remove from the premises all rubbish resulting from work of this trade so as to prevent its accumulation. At the completion of the work contemplated under these Specifications remove from the building and site all rubbish and accumulated materials of whatever nature not caused by the other trades and leave work, and equipment free of all foreign matter including plaster, cement, and paint and leave in a clean, orderly, acceptable and usable condition.

3.8 COORDINATION WITH OTHER TRADES

A. Work in conjunction with each of the other trades to facilitate proper and intelligent execution of work with minimum interference.

B. Carefully examine all architectural structural, mechanical, plumbing, fire protection, and civil drawings and be responsible for the proper fitting of all material and equipment into the building as planned and without interference with other piping, ductwork, conduit or equipment. Proper judgment shall be exercised to secure best possible headroom, door and window clearance, and space conditions throughout; to secure neat arrangement for piping, equipment and conduit: and to overcome all local difficulties and interferences to best advantage. Approval for any and all changes to plans and specifications which may thus be incurred shall be obtained from the Design Professional before proceeding.

C. The Mechanical Contractor shall prepare preliminary sheet metal shop drawings suitable for use in coordinating his work with the work of other trades. The Mechanical Contractor will prepare and furnish CAD files of drawings at 3/8" = 1'-0" scale illustrating the coordination with all trades. Drawing will indicate equipment access requirements, piping, ductwork and conduit in relation to all structural elements of the construction, including floor elevations; steel locations, size, and elevations; partitions locations; door locations and direction of swing; and all other information required to assure coordination of the HVAC, sheet metal and piping trades and fire protection in relation to the Architectural function of the project. Coordination meetings will be held under the supervision of the Owner's Construction Manager and General Contractor. Each trade shall have proper representation at all coordination meetings for the purpose of detailing, on a print of the coordinated drawing mentioned above, the exact location and routing of their work. After the conclusion of the coordination at the working meetings, each trade shall sign the coordinated print, copies of which shall be distributed by the GC to all contractors and parties concerned including the Owner. A print of each final coordination CAD drawing with the participants contractors "signoff' signatures appended shall be submitted to the design professional for record.

D. If contractor installs work so as to cause interference with work of other trades, he shall make necessary changes in work to correct the condition without extra charge.

E. Dimensional layout plans of equipment rooms shall be made showing all bases, pads and inertia blocks required for electrical equipment. Include dimensions of bases, bolt layouts, details, etc.

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

3.9 COORDINATION OF CONTROL EQUIPMENT

A. The HVAC Contractor shall furnish all starters, push buttons for local or remote control, controllers, pressure switches, aquastats, thermostats, float switches or similar items together with all appurtenances and accessories required to operate the equipment furnished under these specifications and necessary to perform the operating functions as specified, shown on the drawings, or otherwise required.

B. The HVAC Contractor will mount and provide power-wiring for all starters and will furnish and install all other safety switches or other line-disconnecting or protective devices. Where the starter and/or safety switch is an integral part of the equipment assembly, the assembly shall be furnished with the wiring complete between starter, controller and motor and the HVAC Contractor will make power connections only.

C. All control wiring to automatic-operated switches, pressure switches, aquastats or other devices which actuate the starter or other items associated with the systems shall be furnished, installed and wired by the HVAC Contractor. The HVAC Contractor will supply 120V electric power to the control panels for these special systems to the extent shown on HVAC Drawings. All other wiring (including additional power circuit if required) shall be the responsibility of the HVAC Contractor.

D. The HVAC Contractor shall carefully check the current characteristics available to each location before ordering motors.

E. If procurement requirements necessitate a change in voltage, phase, horsepower or other characteristics of any motor, the HVAC Contractor shall obtain approval of such change from the Design Professional and shall be responsible for necessary arrangements for notifying the HVAC Contractor, and shall pay the costs, if any, required by the change, including Engineering costs.

F. All HVAC equipment furnished and installed under this contract shall be furnished with full complement of control equipment, control wiring, conduit and all other items necessary for satisfactory operation.

G. The HVAC Contractor will complete all HVAC power connections, through the disconnect and/or thermal cutouts, starter and motor terminals. He will be responsible for final power connections.

H. The HVAC Contractor will be responsible for proper rotation of three phase equipment.

I. All HVAC work, equipment and material furnished under this Section shall be furnished and installed in accordance with the Automation Specifications – Division 23 and HVAC Specifications – Division 26.

J. All panels, relays, terminal boxes, contactors, circuit breakers, safety switches, motor starters and similar items shall be identified by Name, Function and/or Control. Nameplates shall be at least 1 inch x 3 inches with characters not less than a ¼ inch. They shall be made of two laminated black plastic sheets bonded with a middle sheet of white plastic and characters engraved in one black sheet to the depth of the white plastic. A typewritten list of nameplates shall be submitted to the Design Professional for approval before ordering same.

K. Provide pressure sensitive, self adhesive label indicating circuit number on the back of all device plates.

L. Provide pressure sensitive, self adhesive label indicating ‘Emergency’ on the front of all standby or emergency receptacles. Coordinate color with Architect.

M. Provide pressure sensitive, self adhesive label indicating ‘Computer’ on the front of all receptacles connected to the ‘CP**’ panelboards. Coordinate color with Architect.

3.10 ANCHORS AND GUIDES

A. Anchors shall be provided where shown and/or required for the proper control of stress in conduit due to expansion.

3.11 ACCESS

A. All equipment requiring maintenance or adjustment must be accessible. Items located above ceilings shall be located above accessible portions of the ceiling or above access panels provided by this Contractor. Manufactured items with internal components requiring access (whether integral with the enclosure or not) shall be provided with access panels. Access panels shall be provided in ductwork where required for maintenance or adjustment of internal components.

B. Provide access panels in walls and ceilings to give access to all control equipment, junction/pull boxes, and other similar electrical devices which could otherwise be accessible.

C. Access panels shall have not less than No. 16 U.S.S. gauge steel frame, not less than No. 14 U.S.S. gauge steel door, not less than 1/8” neoprene secured to the inside of the door and standard screw driver lock.

D. In unplastered masonry block walls, the height of the panels shall be a multiple of the height of the block courses. All access panels shall not be smaller than 12 inches wide by 18 inches unless otherwise indicated or directed, and shall be installed flush with the finished wall or ceiling and shall be painted with not less than two coats of paint to match adjacent walls.

E. In fire rated assemblies the access panels shall be fire rated.

3.12 FIRE STOPPING

A. All penetrations through fire-resistance-rated floor, fire resistance rated, floor/ceiling assemblies and roof construction and through fire-resistance-rated walls and partitions shall be fire stopped.

B. Penetrations to be fire stopped include both empty openings and those containing cables, pipes, ducts, conduits and any other items.

C. Fire rating of sealed penetrations shall meet or exceed the rating of the assembly being penetrated.

D. Materials shall be installed in accordance with manufacturer's recommendations and their UL listing.

3.13 CONDUIT AND EMT GENERALLY

A. Unless otherwise indicated or specified, all new conduit and EMT devices and controls shall be concealed in walls and ceilings, and wiring devices and controls shall be flush mounted, except in Equipment Rooms.

B. All conduit and EMT shall be installed as closely as possible to walls, columns and structural members so as to occupy a minimum of space. Conduit and EMT shall be run plumb and square with the building lines.

C. All conduits, EMT, fittings and supports shall be installed so as to preserve access to all outlet, junction and pull boxes, and fixtures.

D. All conduit, EMT and other work required by these specifications and by the applicable drawings will be laid out and installed with the complete work of all trades in mind. The Contractor is cautioned that close coordination between trades will be required for the successful completion of this work, and in case interference with the work of other trades should develop, the Design Professional shall determine which work is to be relocated, regardless of which was first installed at no additional expense to the Owner.

E. All conduit, EMT and wireways shall be kept a sufficient distance from other work to permit a clearance of not less than one (1) inch between raceway and the finished covering of ducts, cold water piping, valves and fittings and all adjacent work. Maintain a minimum of three (3) inches from hot water and steam piping.

F. The drawings are generally indicative of the work to be installed and do not indicate all offsets, bends, fittings, supports, boxes, access panels and similar parts which may be specified or required. Contractor shall carefully investigate the structural and finish conditions affecting his work and arrange all his work accordingly furnishing such fittings, bends, supports, boxes, access panels and other similar parts as may be required to meet such conditions.

G. Conduits and EMT penetrating walls and floors shall be installed so that water proofing can be flashed into and around them. Sleeves through exterior walls below grade shall have the annular space between the conduit and/or EMT and sleeve caulked watertight. Sleeves in masonry walls shall be standard weight steel pipe.

H. All exposed conduits in occupied areas must be provided with heavy, solid pattern, painted escutcheons where such materials pass through wall, floors, or ceilings. Escutcheons are not required in equipment rooms or unfinished areas.

3.14 WIRING METHODS

A. All wiring systems shall be contained in raceways. All wiring devices and conduit shall be concealed. Generally, except where otherwise specified or indicated on drawings, wiring shall consist of insulated conductors in rigid zinc-coated steel conduit or EMT concealed within the building construction. Where ceiling system consist of exposed precast plank, wiring shall be run concealed inside plank, and run concealed within the walls. Where conduits must run through exposed joist, all horizontal conduit shall be run fastened along top joist member and conduit dropped down to each lighting fixture, backstop, etc. All conduit within new walls and through

existing building shall be run concealed. Where branch circuits are to be contained in existing construction, and there is hollow spaces within the construction, a flexible conduit system (Greenfield) may be fished within the wall, otherwise cut and patch existing structure to conceal conduit.

B. Wire and cable work shall consist of the various types of wires, cable, connectors, and fittings for complete wire and cable systems as required for the Electrical work. Note that raceways shall be provided for all wiring systems including lighting power, control, paging, intercom, fire alarm, and telephone.

C. Wire and cable shall not be drawn into conduit and raceways until conduit is cleaned. The inside of conduit and raceway shall be dry and clean before wires are pulled.

D. Care shall be exercised in pulling to avoid damage to the wire of cable. Lubricants shall not be used for pulling wire or cable, if the character of the lubricant would otherwise damage the conductors, insulation or jacket. Lubricants used shall be approved by the Design Professional.

E. Wire and cable for feeders, sub-feeders, control and branch circuit wiring shall be color coded. Color coding scheme shall be maintained throughout the project. Submit scheme to Design Professional prior to installation.

F. The switch legs for local wall switches shall have distinctive color coding scheme.

G. Feeder cables shall be tagged in all pull boxes, wireways, and wiring gutters of panels. Tags shall identify wire or cable number and/or piece of equipment served. Tags shall be of non-combustible materials.

3.15 GENERAL PROVISIONS FOR WIRE AND CABLE WORK

A. Branch lighting and receptacle circuits are two wire circuits with individual neutral conductors. Note that branch circuit numbers indicated on drawings are for clarification of circuits only and do not necessarily indicate final connections to panelboard. Branch circuits shall be arranged to balance the loads across the phases of the panelboard feeders. Contractor shall, under final operating conditions, rearrange (rotate) new and existing branch circuits so that a minimum current will flow in each feeder’s neutral cable, with all panelboard branch circuits in use.

B. Contractor shall provide additional conductors as required for 3 way, 4 way switching, separate ballast switching, emergency battery packs, if indicated on drawings, wiring for night lighting if fixtures are so designated, etc.

C. All wiring in cabinets, panelboards, pull boxes, and junction boxes shall be neatly tied and held with Ty-Rap nylon ties.

3.16 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Coordinate with other work, including wires/ cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Maintain electrical service and feeders to occupied areas and operational facilities. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate or abandon existing wiring as noted. At no time shall the life safety or fire alarm systems to the building be without power.

E. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

F. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

G. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL's 486A.

I. Provide flexible metallic conduit for transformers, motor connections, lighting fixtures, and other electrical equipment connections, where subject to movement and vibration.

J. Provide liquid-tight flexible metallic conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:

1) Exterior location;
2) Moist or humid atmosphere where condensate can be expected to accumulate;
3) Corrosive atmosphere;
4) Water spray;
5) Dripping oil, grease or water;
6) Inside air handling units;
7) To all pump motors.

K. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number.

L. Maximum length of all types of flexible conduit shall be 72”.

3.17 MANNER OF INSTALLATION

A. All work shall be installed in a first class, neat and workmanlike manner by mechanics skilled in the trade involved. All details of the installation shall be mechanically and electrically correct.

B. The drawings are generally indicative of the work to be installed but do not indicate all bends, fittings, boxes and specialties which may be required or the exact locations affecting all the work. The CONTRACTOR shall arrange the work accordingly, and furnish such fittings and junction boxes as may be required to meet such conditions at no additional cost to the OWNER, and arrange all runs of conduit to clear beams and other obstructions.

C. Removable panels required for access shall be provided by the CONTRACTOR.

3.18 INSTALLATION OF PULL AND JUNCTION BOXES

A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8-inches square by 4-inches deep.

B. Cable Supports: Install clamps, grids or devices to which cables may be secured. Arrange cables so they may be readily identified. Support conductors inside boxes.

C. Mount pullboxes in inaccessible ceilings with the covers flush with the finished ceiling.

D. Size: Provide pull and junction boxes for telephone, signal and other systems at least 50 percent larger than would be required by Article 314 or NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems. A maximum of (2) 90° bends in conduit or EMT shall occur between junction boxes.

3.19 INSTALLATION OF IDENTIFICATION PRODUCTS

A. Install identification devices in accordance with manufacturer's written instructions and requirements of the NEC.

1) All electrical equipment shall be required to be labeled to comply with OSHA and ANSI/ASME A13.1-2007 standards for the identification of systems.

2) The marking system shall identify the voltage of the contents.

3) All equipment must be identified using phenolic nameplates and labeled in accordance with the nomenclature used on the drawings and compatible with the MIMS System.

B. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

C. Identify Junction, Pull and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange

background. Install on outside of box cover. Also label box covers which identify contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels or plasticized card stock tags at concealed boxes.

D. Conductor Color Coding: Provide color coding for secondary service, feeder and branch circuit conductors throughout the project.

1) Use conductors with color factory-applied the entire length of the conductors except as follows:

a) The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.

(1) Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal point and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

2) Three-phase color coding, Phase A, B, and C order – 480/277 volt shall be brown, orange, yellow, and 208/120 volt shall be black, red, and blue.

E. Power Circuit Identification: Securely fasten identifying metal tags or aluminum wraparound marker bands to cables, feeders and power circuits in vaults, pullboxes, junction boxes, manholes and switchboard rooms with 1/4 inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55 lb. test monofilament line or one-piece self-locking nylon cable ties.

F. Tag or label conductors with vinyl film type wire markers as follows:

1. Multiple Circuits: Provide legend indicating source, voltage, circuit number and phase for branch circuit wiring. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.

2. Match identification markings with designations used in panelboards shop drawings, Contract Documents and similar previously established identification schemes for the facility's electrical installations.

G. Apply warning, caution and instruction signs and stencils as follows:

1) Install warning, caution or instruction signs where required by NEC, where indicated or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.

H. Install equipment/system circuit/ device identification as follows:

1) Apply mechanically fastened equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems. Except as otherwise indicated, provide single line of text, with 1/2-inch high lettering on 1-1/2-inch high label (2-inch high where two lines are required), white lettering in black field. Text shall match terminology and numbering of the Contract Documents and shop drawings. Mechanically apply labels for each unit of the following categories of electrical equipment:

a) Panelboards, electrical cabinets and enclosures

b) Access doors and panels for concealed electrical items

c) Motor starters and VFD's

d) Each feeder circuit breaker or fused switch

e) Disconnect switches

f) Swithgear sections

g) Transformers

h) Lighting control panels

2) Apply circuit/control/items designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere. For panelboards, provide frames, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

I. Provide labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

3.20 LOCATION OF OUTLETS

A. This Contractor shall examine all architectural drawings and details before locating outlets. Outlets shall be placed as required to harmonize with moldings, panels, etc. Outlet locations shall not be obtained from scale dimensions on electrical drawings but from measurements on architectural plans and/or details.

B. If an outlet is installed by this Contractor in such a location as to be out of proper relation to beams, walls, or other details of the building, its location shall be corrected by, and at the expense of this Contractor, at the direction of the Design Professional.

3.21 MOTOR CONNECTIONS AND MECHANICAL EQUIPMENT

A. All electric motors furnished under the General, HVAC, and Plumbing Specifications will be installed by each respective Contractor.

B. The Electrical Contractor shall provide the necessary control wiring, VFD's, disconnects, motor starters, and control equipment, set and wire the units as specified. Control and pilot devices shall be wired by the Electrical Contractor. All interlock wiring shall be provided by the Electrical

Contractor. Provide disconnect switches for all motors and packaged HVAC equipment whether or not shown on the drawings.

C. The Electrical Contractor shall run power and control wiring system for the various points indicated to the motor outlets and connect up complete and ready for operation.

D. Switch, wire, and conduit sizes are based on manufacturer's published literature. Any changes required due to the nameplate information on the equipment shall be made by this Contractor at no additional cost to the Owner.

E. The horsepower of motors or wattage of equipment indicated on electrical plans or in schedules on drawings is the estimated horsepower or wattage requirement of equipment furnished under other sections of the specifications. All feeders, conduit and wiring, motor starters and circuit breakers shall be of the sizes and capacities to suit the horsepower of the motors or wattage of equipment actually furnished under the various sections of the specifications. However, in no case shall the feeders and branch circuits, and circuit breakers be of smaller capacities or sizes than those indicated on drawings or specified. The Contractor shall coordinate the requirements of the various sections of the project specifications and provide suitable equipment and electrical facilities therefore in order that the above requirements may be met.

F. Obtain and review shop drawings, product data, manufacturer’s wiring diagrams, and manufacturer’s instructions for equipment furnished under other sections.

G. Determine connection locations and requirements.

H. Sequence rough-in of electrical connections to coordinate with installation of equipment.

I. Sequence electrical connections to coordinate with start-up of equipment.

J. Electrical Contractor shall size motor overload protection in the field. Sizes shall be based on the motor’s name plate data.

K. All motor frames shall be grounded. Electric power, control and grounding connections shall be factory wired to an outlet box or terminal strip enclosure on the apparatus for easy connection by the Contractor.

L. Motors for use on equipment with variable speed drives shall be compatible for drive usage and be constructed per NEMA Standard MG-1 Part 31. Coordinate with variable speed drive manufacturer for motor requirements and drive output characteristics. All such motors shall have their cases bonded to the driven machinery frame with a ground strap.

M. Disconnect switches shall be furnished by the equipment manufacturer. If disconnect switches are not available from the equipment manufacturer they shall be provided by the Electrical Contractor. Coordinate with the Architectural, Mechanical, Plumbing, Fire Protection, and Civil drawings and specifications.

N. Disconnect switches shall be as specified within the equipment specifications and shall suit the environment in which installed.

3.22 COLOR CODING OF RACEWAYS AND BOXES

A. Junction boxes shall be primed and painted with the following colors:

480/277V	Dark Blue
208/120V	Light Blue
Voice/Data/Communication	Yellow
Fire Alarm	Red

3.23 ELECTRICAL DRAWINGS

A. The Contractor shall note that the Electrical Drawings are intended to indicate only the extent diagrammatically, general character, and locations of the work included. Work intended but having minor details obviously omitted or not shown shall be furnished and installed complete to perform the functions intended. For building details the Architectural and Structural Drawings, and Mechanical, Plumbing, and Fire Protection Drawings and Specifications shall be followed and the work of the Electrical Drawings and Specification shall be coordinated and fitted thereto.

B. Riser diagrams are schematic and are provided to indicate the system in general to be installed. This information may or may not be duplicated on the plans; however, equipment shown on either the plans or riser diagrams and schematics shall be provided as if shown on both.

C. In general, the number of wires in each branch circuit raceway has not been indicated, but shall be provided as required.

D. Arrangements of conduit wiring and equipment that differ materially from the obvious intent of the drawing will not be permitted except where necessary to avoid interferences and then, or except when, specifically approved by the Design Professional.

E. In case of conflict between that Specified and the Drawings, the proper interpretation shall be made by the Design Professional whose decision shall be binding.

3.24 ABANDONMENT, REMOVAL, AND RELOCATIONS

A. All removed equipment and material not wanted by the Owner shall become the property of the Contractor and shall be removed immediately from the site.

B. Any existing apparatus or device required to remain in operation, although not specifically shown or mentioned, shall be connected or reconnected and supplied from an available source of power.

C. Remove all equipment, backboxes, branch circuit wiring and control wiring for devices and equipment that are not required in the new facilities.

D. Any existing apparatus or device to be retained shall be disconnected and relocated and reinstalled as required to allow for new wall or ceiling finishes.

E. Provide new typed panel schedules on each new and existing panelboard and switchboard describing each circuit.

3.25 ELECTRICAL EQUIPMENT LOCATIONS

A. The plans accompanying this specification have been drawn to scale and indicate the general arrangement required, but small-scale plans are diagrammatic and the Electrical Contractor shall be guided by the mounting heights noted herein or on the drawings.

B. All locations are subject to changes that will ease installation or may be necessary to avoid obstacles in building construction.

C. The Electrical Contractor shall verify all dimensions and conditions at the site and check the layout for sizes and clearances to be sure that the apparatus and materials he proposed to furnish may be installed and operate satisfactorily in the space allotted to it. Equipment and wiring shall be installed in accessible locations.

D. Before installing any work, the Electrical Contractor shall have obtained final locations of all outlets and equipment from the Mechanical, Plumbing, and Fire Protection Contractors, and he shall examine drawings for other trades and avoid interferences with their work. In cases of interference, priority of installation will not relieve the Electrical Contractor of his responsibility to avoid interferences.

E. No changes are to be made in the original design without the written approval of The Design Professional.

F. Unless otherwise located to comply with "Handicap Regulations" or indicated on Electrical or Mechanical drawings, mounting heights shall be as follows:

Wall Switches	48” above finished floor
Convenience Outlets	18” above finished floor unless otherwise indicated or located above countertops and 48” above finished floor in Mechanical Rooms
Starters, Disconnect Switches and Enclosed Circuit Breakers	5'-0" to center line from finished floor
Panelboards	6'-6" to top circuit breaker
Fire Alarm Horn/Strobes	80” above finished floor
Fire Alarm Pullstations	As noted
Voice/Data Outlets	18” above finished floor unless otherwise indicated
Video/Cable TV Outlets	Coordinate with Architect prior to rough-in

END OF SECTION 260500

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MEDIUM-VOLTAGE CABLES

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SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section Includes:
1. Medium voltage cable.
2. Cable terminations.
3. Fireproofing tape.
4. Underground cable markers.
5. Bedding and cover materials.

1.3 REFERENCES

A. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.4 SUBMITTALS

A. Product Data: Submit for cable, terminations, and accessories.

B. Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual sizes and locations of cables.

B. Operation and Maintenance Data: Submit instructions for testing and cleaning cable and accessories.

1.6 QUALIFICATIONS

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect cable ends from entrance of moisture.

PART 2 PRODUCTS

2.1 MEDIUM VOLTAGE CABLE

A. Manufacturers:
   1. Diamond Wire & Cable Co.
   2. Essex Group Inc.
   3. General Cable Co.
   4. The Okonite Company.
   5. The Kerite Company.
   6. Pirelli Cable Corporation.
   7. Rome Cable Corporation.
   8. Southwire.

B. Voltage: 15 kV.

C. Insulation: EPR

D. Insulation Level: 133 percent of operating voltage.

E. Cable Continuous Operating Temperature Rating: MV-105.

F. Configuration: Single conductor.

G. Conductor Material: Aluminum.

H. Conductor Construction: Compact stranded.

I. Conductor Shield: Foil.

J. Non-Armor Jacket: Thermo-plastic rubber with red extruded identification stripe.

2.2 CABLE TERMINATIONS

A. Voltage: 15 kV.

B. Location: Indoor at equipment, and outdoor at manholes.

C. Conductor Quantity: Single core.

D. Type: Separable molded elbow connectors.

2.3 FIREPROOFING TAPE

A. Manufacturers:
1. 3M Electrical Products Division.
2. Plymouth Rubber Co., Bishop Division.

B. Product Description: Flexible, conformable fabric, coated on one side with flame retardant, flexible polymeric or chlorinated elastomer. Non-corrosive to and compatible with cable sheaths jackets. Does not support combustion.

C. Width: Approximately 3 inches.

D. Thickness: Not less than 0.03 inch.

E. Weight: Not less than 2.5 pounds per square yard.

2.4 PULLING CABLES IN DUCTS, MANHOLES

A. Medium-voltage cables shall be pulled into ducts and utility tunnels with equipment designed for this purpose, including power-driven winch, cable-feeding flexible tube guide, cable grips, and lubricants. A sufficient number of trained personnel and equipment shall be employed to ensure the careful and proper installation of the cable.

B. Cable reel shall be set up at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Flexible tube guide shall be installed through the opening in a manner that will prevent the cable from rubbing on the edges of any structural member.

C. Cable shall be unreeled from the top of the reel. Payout shall be carefully controlled. Cable to be pulled shall be attached through a swivel to the main pulling wire by means of a pulling eye. Woven-wire cable grips shall be used to grip the cable end when pulling small cables and short straight lengths of heavier cables.

D. Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure. Pulling eyes and cable grips shall be used together for nonmetallic sheathed cables to prevent damage to the cable structure.

E. Cables shall be liberally coated with a suitable cable-pulling lubricant as it enters the tube guide or duct. Nonmetallic sheathed cables shall be covered with wire-pulling compounds when required which have no deleterious effects on the cable. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the minimum bending radius of the cable.

F. Cables shall be pulled into ducts at a speed not to exceed 50 feet per minute and not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately with any indication of binding or obstruction and shall not be resumed until such difficulty is corrected.

2.5 SPLICES AND TERMINATIONS

A. Cable splices made up in manholes or utility tunnels shall be firmly supported on cable racks as indicated. No cable splices shall be pulled in ducts. Cable ends shall overlap at the ends of a section to provide sufficient undamaged cable for splicing. Cables to be spliced in manholes or utility tunnels shall overlap the centerline of the proposed joint by not less than 2 feet.

B. Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture. Nonleaded cables shall be sealed with rubber tape wrapped down to 3 inches from the cable end. Rubber tape shall be cover-wrapped with polyvinylchloride tape. Splices shall be made in manholes or junction boxes, except where cable terminations are specifically indicated. Splicing and terminating of cables shall be expedited to minimize exposure and cable deterioration.

C. Cables shall be terminated utilizing molded rubber terminations and shall be provided with adequate means for making external connections to the cable conductors of single-conductor cables; protecting the cable insulation against moisture, oil, or other contaminant; physically protecting and supporting cables, and maintaining the insulation level of the cable. Molded rubber terminations shall be field fabricated from termination kits supplied by and in accordance with the termination manufacturer’s recommendations for the type, size, and electrical characteristics of the cable.

D. Installation shall include built-up or prefabricated heat or cold shrink stress-relief cones at the terminals of all shielded cables rated 15 kV and above, ungrounded.

E. Cable splices shall be with 600 Amp Deadbeak separable connectors supplied by and in accordance with the cable manufacturer's recommendations for the type, size, and electrical characteristics of the cable specified. Cable splices in manholes shall be located midway between cable racks on walls of manholes and supported with cable arms at approximately the same elevation as the enclosing duct. Separable connectors shall have insulating plug with cap, capacitive test point, and shield/drain wire.

F. Cable splices in junction boxes shall be installed on cable racks or by other approved methods which will minimize physical stress on the splice connections. Splices shall be supported at approximately the same elevation as the installed cable except where space limitations or existing cable length limitations make this method impractical or impossible.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Verify conduit, duct, and manholes are ready to receive cable.

C. Verify routing and termination locations of cable prior to rough-in.

3.2 PREPARATION

A. Use swab to clean conduits and ducts before pulling cables.

3.3 INSTALLATION

A. Avoid abrasion and other damage to cables during installation.

B. Use suitable manufacturer approved lubricants and pulling equipment.

C. Sustain cable pulling tensions and bending radii below manufacturer's recommended limits.

D. Ground cable shield at each termination and splice.

E. Install cables in manholes along wall providing longest route.

F. Arrange cable in manholes to avoid interference with duct entrances.

3.4 FIREPROOFING

A. Apply fireproofing tape to cables when installed in manholes, cable rooms, pull boxes, or other enclosures.

B. Smooth out irregularities, at splices or other locations, with insulation putty before applying fireproofing tape.

C. Apply fireproofing tape tightly around cables spirally in half-lapped wrapping or in butt jointed wrapping with second wrapping covering joints first.

D. Extend fireproofing 1 inch into conduit or duct.

E. Install tape with coated side toward cable.

F. Install random wrappings of plastic tape around fireproofing tape to prevent unraveling.

G. Install fireproofing to withstand a 200 Ampere arc for 30 seconds.

3.5 FIELD QUALITY CONTROL

A. Inspect exposed cable sections for physical damage.

B. Inspect cable for proper connections, and phase rotation.

C. Inspect shield grounding, cable supports, and terminations for proper installation.

D. Each shall be tested per NETA requirements and after the installation of high-voltage power cables has been completed, including splices, joints, and terminations, and before the cable is energized. Test equipment, labor, and technical personnel shall be provided as necessary to perform the electrical acceptance tests.

E. Arrangements shall be made to have tests witnessed and approved by the Contracting Officer. Each power-cable installation shall be completely isolated from extraneous electrical connections at cable terminations and joints. Safety precautions shall be observed. Test data shall be recorded and shall include identification of cable and location, megohm readings versus time, leakage current readings versus time, and cable temperature versus time.

F. Final acceptance shall depend upon the satisfactory performance of the cable under test. No cable shall be energized until recorded test data have been approved by the Contracting Officer Final test reports shall be provided to the Contracting Officer. Reports shall be sealed by a professional engineer and have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Report."

3.6 PROTECTION OF INSTALLED CONSTRUCTION

A. Protect installed cables from entrance of moisture.

END OF SECTION

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section includes building wire and cable; armored cable; metal clad cable; and wiring connectors and connections.

B. Related Sections:
1. Section 26 05 53 - Identification for Electrical Systems: Product requirements for wire identification.
2. Section 31 23 17 - Trenching: Execution requirements for trenching required by this section.
3. Section 31 23 23 - Fill: Requirements for backfill to be placed by this section.

1.3 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.

C. Underwriters Laboratories, Inc.:
1. UL 1277 - Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.4 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 16 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 -2 insulation, in raceway or Metal Clad (MC) Cable.
2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN -2 insulation, in raceway.
3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN -2 insulation, in raceway or Metal Clad (MC) Cable.
4. Wet or Damp Interior Locations: Use only building wire, Type XHHW -2 insulation, in raceway.
5. Exterior Locations: Use only building wire, Type XHHW -2 insulation, in raceway.
6. Underground Locations: Use only building wire, Type XHHW -2 insulation, in raceway.

1.5 DESIGN REQUIREMENTS

A. Conductor sizes are based on copper unless indicated as aluminum or "AL".

B. When aluminum conductor is substituted for copper conductor, size to match circuit requirements, terminations, conductor ampacity and voltage drop.

1.6 SUBMITTALS

A. Product Data: Submit for building wire and each cable assembly type.

B. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors.

C. Test Reports: Indicate procedures and values obtained.

1.7 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of components and circuits.

1.8 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.

1.9 QUALIFICATIONS

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

1.10 COORDINATION

A. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

PART 2 PRODUCTS

2.1 GENERAL BUILDING WIRE

A. Manufacturers:
1. AETNA.
2. American Insulated Wire Corp.
3. Colonial Wire.
4. Encore Wire.
5. General Cable Co.
6. Republic Wire.
7. Rome Cable.
8. Service Wire Co.
9. Southwire.
10. Superior Essex.
11. Carol Cable Co. Inc.
12. Draka.
13. Tyco.
14. Pyrotenax.
15. Raychem.

B. Product Description: Single conductor insulated wire.

C. Conductor: Copper

D. Insulation Voltage Rating: 600 volts.

E. Insulation Temperature Rating: 90 degrees C.

2.2 METAL CLAD CABLE

A. MC cable shall be a galvanized spiral steel assembly with 90ºC THHN copper wires included and approved fittings and couplings by AFC Company. Cable shall have green insulated ground wire. Use only where cable can be concealed.

B. MC cable shall be used only when concealed above ceilings or in walls. Install all exposed wiring in raceway, including wiring in closets. Extend raceway from surface mounted panelboards to an accessible location above ceiling. Provide junction box when transitioning from raceway to MC cable.

2.3 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. Verify interior of building has been protected from weather.

B. Verify mechanical work likely to damage wire and cable has been completed.

C. Verify raceway installation is complete and supported.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

A. Route wire and cable to meet Project conditions.

B. Neatly train and lace wiring inside boxes, equipment, and panelboards.

C. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

D. 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.

E. Special Techniques - Cable:
1. Protect exposed cable from damage.
2. Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.
3. Use suitable cable fittings and connectors.

F. 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.
7. Terminate aluminum conductors with tin-plated, aluminum-bodied compression connectors only. Fill with anti-oxidant compound before installing conductor.
8. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.

G. Install solid conductors for branch circuits 10 AWG and smaller.

H. Install terminal lugs on ends of 600 volt wires unless lugs are furnished on connected device, such as circuit breakers.

I. Size lugs in accordance with manufacturer's recommendations terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.

J. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2-1/2 times normal potential of circuit.

K. Coordinate cable installation with other Work.

L. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

M. Use pulling means including, fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

N. Conceal all cable in finished spaces.

O. Keep conductor splices to a minimum.

P. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cables in individual circuits. Make terminations so there is no bare conductor at the terminal.

Q. Increase branch circuit wire size to limit voltage drop to 3% at full load conditions.

R. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

S. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

T. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

U. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

V. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL's 486A.

W. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number.

X. Unless otherwise indicated, each single phase branch circuit shall consist of a respective insulated phase conductor, an insulated dedicated neutral conductor, and a separate insulated equipment ground wire.

Y. All 120 V branch circuits between 60’ and 100’ in length shall be circuited with a minimum of #10 AWG wire. Branch circuits between 100’ and 150’ in length shall be circuited with a minimum of #8 AWG wire. Wire sizes shall be increased to limit voltage drop to three percent (3%).

Z. Provide separate neutral conductor and ground wire for each branch circuit. Provide separate ground wire in each feeder circuit.

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. Colors are as follows:
      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.

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.

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.

C. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.

D. Prior to energizing, test wires and cables for electrical continuity and for short-circuits.

E. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper function. Correct malfunctioning units, and retest to demonstrate compliance.

END OF SECTION

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section Includes:
1. Rod electrodes.
2. Building perimeter ground system.
3. Wire.
4. Grounding well components.
5. Mechanical connectors.
6. Exothermic connections.

B. Applications of electrical grounding and bonding work in this section includes the following:
1. Electrical power systems
2. Raceways
3. Enclosures
4. Equipment
5. Lighting fixtures
6. Underground metal piping
7. Underground metal water piping
8. Underground metal structures
9. Metal building frames
10. Grounding electrodes
11. Separately derived systems
12. Service equipment
13. Lighting standards
14. Interior metallic piping
15. Water service

C. GROUNDING AND BONDING IN GENERAL
1. Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including but not limited to, cables/wires, connectors, solderless lug terminals, bonding jumper braid, surge arresters and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL and IEEE requirements and with established industry standards for those applications indicated.

1.3 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.
2. NFPA 99 - Standard for Health Care Facilities.

1.4 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:
1. Metal underground water pipe.
2. Metal building frame.
3. Concrete-encased electrode.
4. Ground ring.
5. Rod electrode.
6. Plate electrode.
7. Concrete reinforcing.

1.5 DESIGN REQUIREMENTS

A. Construct and test grounding systems for access flooring systems on conductive floors accordance with IEEE 1100.

1.6 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms maximum.

1.7 SUBMITTALS

A. Product Data: Submit data on grounding electrodes and connections.

B. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

C. Manufacturer's Installation Instructions: Submit for active electrodes.

1.8 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of components and grounding electrodes.

1.9 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

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 ten years documented experience.

1.11 PRE-INSTALLATION MEETINGS

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

1.12 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.13 COORDINATION

A. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

A. Manufacturers:
1. Erico, Inc.
2. O-Z Gedney Co.
3. Thomas & Betts, Electrical.

B. Product Description:
1. Material: Copper-clad steel.
2. Diameter: 5/8 inch.
3. Length: 10 feet.

C. Connector: Connector for exothermic welded connection.

2.2 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: #4/0 AWG.

C. Grounding Electrode Conductor: Copper conductor bare.

D. Bonding Conductor: Copper conductor bare.

E. Unless otherwise indicated, provide electrical grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC or as shown on the drawings if oversized by Engineer.

F. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 4 AWG and larger shall be permitted to be identified per NEC.

G. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 10 AWG and smaller shall be ASTM B1 solid bare copper wire.

H. Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.

I. Telecom System Grounding Riser Conductor: Telecommunications Grounding Riser shall be a 1/0 AWG insulated stranded copper grounding conductor unless indicated otherwise.

J. Electrical System Grounding: Conductor sizes shall not be less than what is shown on the drawings and not less than required by the NEC, whichever is greater.

2.3 ELECTRICAL GROUNDING CONNECTION ACCESSORIES

A. Provide electrical insulating tape, heat shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service indicated.

2.4 BONDING JUMPER BRAID

A. Copper braided tape, constructed of 30-gauge bare copper wires and properly sized for indicated applications.

2.5 FLEXIBLE JUMPER STRAP

A. Flexible flat conductor, 480 strands of 30-gauge bare copper wire; 3¾"wide, 9½ " long; 48, 250 CM. Select braid with holes sized for 3/8" diameter bolts, and protect braid with copper bolt hole ends.

2.6 BONDING PLATES, CONNECTORS, TERMINALS, AND CLAMPS

A. Provide bonding plates, connectors, terminals, lugs, and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.

2.7 SPLICES AND TERMINATION COMPONENTS

A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.8 TELECOMMUNICATION SYSTEM GROUND BUSBARS

A. Provide solid copper busbar, pre-drilled from two-hole lug connections with a minimum thickness of 1/4 inch for wall and backboard mounting using standard insulators sized as follows:
   1. Room Signal Grounding: 12 inches x 4 inch. (Located in each Server Room, IDF, and AV Closet).
   2. Master Signal Ground: 24 inches x 4 inch. (Located in MDF).

2.9 GROUND CONNECTIONS

A. Below Grade: Exothermic-welded type connectors.

B. Above Grade:
   1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
   2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
   3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.
   4. Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.

5. Equipment rack and cabinet ground bars. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 3/8 inch x ¾ inch.

2.10 GROUND TERMINAL BLOCKS

A. At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.11 SPLICE CASE GROUND ACCESSORIES

A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 6 AWG insulated ground wire with shield bonding connectors.

2.12 GROUNDING WELL COMPONENTS

A. Well Pipe: 8 inches NPS by 24 inches long clay tile, or concrete pipe with belled end.

B. Well Cover: Cast iron or fiberglass with legend “GROUND” embossed on cover.

2.13 MECHANICAL CONNECTORS

A. Manufacturers:
1. Erico, Inc.
2. ILSCO Corporation.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical.

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.14 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. Copperweld, Inc.
2. ILSCO Corporation.
3. O-Z Gedney Co.
4. Thomas & Betts, Electrical.

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. Verify final backfill and compaction has been completed before driving rod electrodes.

B. Installer of grounding shall examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 PREPARATION

A. Remove paint, rust, mill oils, and surface contaminants at connection points.

3.3 EXISTING WORK

A. Modify existing grounding system to maintain continuity to accommodate renovations.

B. Extend existing grounding system using materials and methods as specified.

3.4 INSTALLATION

A. General: Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

C. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus or bushing.

D. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

E. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible to minimize transient voltage rises.

F. Install clamp-on connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

G. Route properly sized (NEC Article 250) grounding conductors with each feeder and branch circuit.

H. Ground each separately-derived system as follows:
   1. The grounded conductor of the separately derived system shall be bonded to the nearest available point of the interior metal water piping system in the area served by the separately derived system. This connection shall be made at the same point on the separately derived system where the grounding electrode conductor is connected. The bonding jumper shall be sized in accordance with the NEC.

I. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors and plumbing systems.

J. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

K. Install rod electrodes approximately every 60 feet around perimeter of building interconnected with #4/0 ground wire.

L. Install grounding and bonding conductors concealed from view.

M. Install grounding well pipe with cover at each rod location. Install well pipe top flush with finished grade.

N. Install grounding electrode conductor and connect to reinforcing steel in foundation footing. Electrically bond steel together.

O. Bond together metal siding not attached to grounded structure; bond to ground.

P. Bond together reinforcing steel and metal accessories in fountain structures.

Q. Connect to site grounding system, and each exterior lighting pole.

R. Bond to lightning protection system.

S. Install continuous grounding for underground cold water system and building steel.

T. 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.

U. 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.

V. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.5 SYSTEM GROUNDING

A. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.

B. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

3.6 EQUIPMENT GROUNDING

A. Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.7 INACCESSIBLE GROUNDING CONNECTIONS

A. Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

3.8 MEDIUM-VOLTAGE EQUIPMENT AND CIRCUITS

A. Switchgear: Provide a bare grounding electrode conductor from the switchgear ground bus to the grounding electrode system.

B. Duct Banks and Manholes: Provide an insulated equipment grounding conductor in each duct containing medium or high voltage conductors, sized per NEC except that minimum size shall be #4/0 AWG. Bond the equipment grounding conductors to the switchgear ground bus, to all manhole hardware and ground rods, to the cable shielding grounding provisions of medium or high voltage cable splices and terminations, and equipment enclosures.

C. Lighting Arresters: Connect lightning arresters to the equipment ground bus or ground rods as applicable.

D. Metallic Conduit: Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.

3.9 SECONDARY EQUIPMENT AND CIRCUITS

A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service

B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
   1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
   2. Provide a supplemental ground electrode and bond to the grounding electrode system.

C. Service Disconnect (Separate Individual Enclosure): Provide a ground bar bolted to the enclosure with lugs for connecting the various grounding conductors.

D. Switchgear, Switchboards, Unit Substations, and Motor Control Centers:
   1. Connect the various feeder equipment grounding conductors to the ground bus in the enclosure with suitable pressure connectors.
   2. For service entrance equipment, connect the grounding electrode conductor to the ground bus.
   3. Connect metallic conduits, which terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.

E. Transformers
   1. Exterior: Exterior transformers supplying interior service equipment shall have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.
   2. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the nearest component of the grounding electrode system or the ground bar at the service equipment.

F. Conduit Systems
   1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
   2. Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
   3. Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.

G. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.

H. Boxes, Cabinets, Enclosures, and Panelboards
   1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes.
   2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
   3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

I. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.

J. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

K. Ground lighting fixtures to the equipment grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

L. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.10 CORROSION INHIBITORS

A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.11 CONDUCTIVE PIPING

A. Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

3.12 LIGHTNING PROTECTION SYSTEM

A. Bond the lightning protection system to the electrical grounding electrode system.

3.13 TELECOMMUNICATIONS SYSTEM

A. Bond telecommunications system grounding equipment to the electrical grounding electrode system.

B. Furnish and install all wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.

C. Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.

D. Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milliohms or less.

E. Below-Grade Grounding Connections: When making exothermic welds, wire brush or file the point of contact to a bare metal surface. Use exothermic welding cartridges and molds in accordance with the manufacturer’s recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly cleaned the joint area. Notify the Resident Engineer prior to backfilling any ground connections.

F. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.

G. Bonding Jumpers:
1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 6 AWG insulated copper wire.
2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
3. Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.

H. Bonding Jumper Fasteners:
1. Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
3. Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.
4. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

3.14 ELECTRICAL ROOM GROUNDING

A. Building Earth Ground Busbars: Provide ground busbar hardware at each electrical room and connect to pigtail extensions of the building grounding ring.

3.15 COMMUNICATION ROOM GROUNDING (TR/TER/AV CLOSETS)

A. Telecommunications Ground Busbars:
1. Provide communications room telecommunications ground busbar hardware at 18 inches above finish floor.
2. Connect the telecommunications room ground busbars to other room grounding busbars provided by Others.

B. Telephone-Type Cable Rack Systems: aluminum pan installed on telephone-type cable rack serves as the primary ground conductor within the communications room. Make ground connections by installing the following bonding jumpers:
1. Install a 6 AWG bonding between the telecommunications ground busbar and the nearest access to the aluminum pan installed on the cable rack.
2. Use 6 AWG bonding jumpers across aluminum pan junctions.

C. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:
   1. When ground bars are provided at the rear of lineup of bolted together equipment racks, bond the copper ground bars together using solid copper splice plates supplied by the ground bar manufacturer.
   2. Bond together nonadjacent ground bars on equipment racks and cabinets with 6 AWG insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
   3. Provide a 6 AWG bonding jumper between the rack and/or cabinet ground busbar and the aluminum pan of an overhead cable tray or the raised floor stringer as appropriate.

D. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near the top of backboards used for communications cross-connect systems. Connect backboard ground terminals to the aluminum pan in the telephone-type cable tray using an insulated 16 AWG bonding jumper.

E. Bond each conduit interconnecting the TR's and TER's to the ground busbar.

Other Communication Room Ground Systems: Ground all metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to the cable tray pan or the telecommunications ground busbar, whichever is closer, using insulated 6 AWG ground wire bonding jumpers.

3.16 COMMUNICATIONS CABLE GROUNDING

A. Bond all metallic cable sheaths in multipair communications cables together at each splicing and/or terminating location to provide 100 percent metallic sheath continuity throughout the communications distribution system.
   1. At terminal points, install a cable shield bonding connector provide a screw stud connection for ground wire. Use a bonding jumper to connect the cable shield connector to an appropriate ground source like the rack or cabinet ground bar.
   2. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or the splice case grounding and bonding accessories provided by the splice case manufacturer. When an external ground connection is provided as part of splice closure, connect to an approved ground source and all other metallic components and equipment at that location.

3.17 COMMUNICATIONS CABLE TRAY SYSTEMS

A. Bond the metallic structures of one cable tray in each tray run following the same path to provide 100 percent electrical continuity throughout this cable tray systems as follows:
   1. Splice plates provided by the cable tray manufacturer can be used for providing a ground bonding connection between cable tray sections when the resistance across a bolted connection is 10 milliohms or less. The Contractor shall verify this loss by testing across one slice plate connection in the presence of the Contractor.
   2. Install a 6 AWG bonding jumper across each cable tray splice or junction where splice plates cannot be used.
   3. When cable tray terminations to cable rack, install 6 AWG bonding jumper between cable tray and cable rank pan.

4. Bond cable tray to interconnecting conduit system.

3.18 COMPUTER ROOM GROUNDING

A. Conduit: ground and bond metallic conduit systems as follows:
   1. Ground metallic service conduit and any pipes entering or being routed within the computer room at each end using 6AWG bonding jumpers.
   2. Bond at all intermediate metallic enclosures and across all joints using 6 AWG bonding jumpers.

3.19 WIREWAY GROUNDING

A. Bond the metallic structures of wireway to provide 100 percent electrical continuity throughout the wireway system by connecting a 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.

B. Install insulated 6 AWG bonding jumpers between the wireway system bonded as required in paragraph 1 above, and the closest building ground at each end and approximately every 50 feet.

C. Use insulated 6 AWG bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and cross all section junctions.

D. Use insulated 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 30 feet.

3.20 COMMUNICATION RACEWAY GROUNDING

A. Conduit: Use insulated 6 AWG bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.

B. Wireway: use insulated 6 AWG bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and across all section junctions.

C. Cable Tray Systems: Use insulated 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 50 feet.

3.21 GROUND RESISTANCE

A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Owner. Final tests shall assure that this requirement is met.

B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below

grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

C. Services at power company interface points shall comply with the power company ground resistance requirements.

D. Below-grade connections shall be visually inspected by the Owner prior to backfilling. The Contractor shall notify the Owner 24 hours before the connections are ready for inspection.

3.22 GROUND ROD INSTALLATION

A. Drive each rod vertically in the earth, not less than 10 feet in depth.

B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

3.23 GROUNDING FOR RF/EMI CONTROL

A. Install bonding jumpers to bond all conduit, cable trays, sleeves and equipment for low voltage signaling and data communications circuits. Bonding jumpers shall consist of 4 inches wide copper strip or two 10 AWG copper conductors spaced minimum 4 inches apart. Use 6 AWG copper where exposed and subject to damage.

B. Comply with the following when shielded cable is used for data circuits.
1. Shields shall be continuous throughout each circuit.
2. Connect shield drain wires together at each circuit connection point and insulate from ground. Do not ground the shield.
3. Do not connect shields from different circuits together.
4. Shield shall be connected at one end only. Connect shield to signal reference at the origin of the circuit. Consult with equipment manufacturer to determine signal reference.

3.24 FIELD QUALITY CONTROL:

A. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.

B. Perform ground resistance testing in accordance with IEEE 142.

C. Perform continuity testing in accordance with IEEE 142.

D. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION

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SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 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.

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.

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.

E. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

1.4 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.

1.5 SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479, to achieve fire ratings of adjacent construction in accordance with FM, UL, and WH.

B. Firestop interruptions to fire rated assemblies, materials, and components.

1.6 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code FM, UL, and WH for fire resistance ratings and surface burning characteristics.

B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.7 SUBMITTALS

A. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

B. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

C. 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.

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.
2. Firestopping: Submit preparation and installation instructions.

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

G. 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.

1.8 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.

1.9 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 10 years documented experience.

1.10 PRE-INSTALLATION MEETINGS

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

1.11 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.12 ENVIRONMENTAL REQUIREMENTS

A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

C. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. Electroline Manufacturing Company.
3. O-Z Gedney Co..

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.

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

2.3 SLEEVES

A. Sleeves for conduit Through Non-fire Rated Floors: Steel pipe.

B. Sleeves for conduit, bus duct, and cable tray Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

C. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.4 MECHANICAL SLEEVE SEALS

A. Manufacturers:
   1. Thunderline Link-Seal, Inc.
   2. NMP Corporation.

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.

2.5 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.

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 or Multiple component silicone elastomeric compound and compatible silicone sealant.
   2. Foam Firestopping Compounds: Single or Multiple 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 and ceramic 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.

2.6 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 conduit is exposed.
   2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. 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 backing materials to arrest liquid material leakage.

D. Obtain permission from Design Professional before using powder-actuated anchors.

E. Do not drill or cut structural members.

F. Obtain permission from Design Professional before drilling or cutting structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
   1. Concrete Structural Elements: Provide precast inserts, expansion anchors, powder actuated anchors, and preset inserts.
   2. Steel Structural Elements: Provide beam clamps, steel ramset fasteners, and welded fasteners.
   3. Concrete Surfaces: Provide 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 - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.

D. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

E. Place intumescent coating in sufficient coats to achieve rating required.

F. Remove dam material after firestopping material has cured.

G. Fire Rated Surface:
   1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
      b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
      c. Pack void with backing material.
      d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
   2. Where cable tray, bus, cable bus, conduit, wireway, and trough, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

H. Non-Rated Surfaces:
   1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
      b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
      c. Install type of firestopping material recommended by manufacturer.
   2. Install escutcheons, floor plates, and ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
   3. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.
   4. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members and formed steel channel. Brace and fasten with flanges bolted to structure.

3.6 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 3 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 airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install stainless steel escutcheons at finished surfaces.

3.7 FIELD QUALITY CONTROL

A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

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SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

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SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 29 - Hangers and Supports for Electrical Systems.
3. Section 26 05 34 - Floor Boxes for Electrical Systems.
4. Section 26 05 53 - Identification for Electrical Systems.
5. Section 26 27 16 - Electrical Cabinets and Enclosures.
6. Section 26 27 26 - Wiring Devices.
7. Section 27 05 33 - Conduits and Backboxes for Communications Systems.
8. Section 27 05 36 - Cable Trays for Communications Systems.
9. Section 28 05 33 - Conduits and Backboxes for Electronic Safety and Security.
10. Section 28 05 36 - Cable Trays for Electronic Safety and Security.

1.3 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.

1.4 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. Wiring Methods

1. Interior Wiring

a. Feeders - Electrical Metallic Tubing (EMT).

b. Exposed Branch Circuits - Electrical Metallic Tubing (EMT).

c. Concealed Branch Circuits - Metal Clad Cable (MC).

d. Voice/Data/Video - Electrical Metallic Tubing (EMT).

e. Fire Alarm - Electrical Metallic Tubing (EMT).

f. Building Controls - Electrical Metallic Tubing (EMT).

g. Connection to Vibrating Equipment - Flexible Metallic Conduit (FMC).

h. Connection to Pumps - Liquid-Tight Flexible Metallic Conduit (LFMC).

2. Exterior Wiring Below Grade

a. Feeders – Schedule 40 Non-Metallic Conduit (PVC) encased in concrete ductbank.

b. Branch Circuits – Schedule 80 Non-Metallic Conduit (PVC).

c. Control Circuits – Schedule 80 Non-Metallic Conduit (PVC).

d. PVC transition to above grade/slab - Galvanized Rigid Steel Conduit (GRS).

e. PVC transition to inside building - Galvanized Rigid Steel Conduit (GRS).

f. Link-seals for all conduits entering building horizontally below grade.

3. Exterior Wiring Above Grade

a. Feeders – Rigid Aluminum Conduit (RAC)

b. Branch Circuits – Rigid Aluminum Conduit (RAC)

c. Control Circuits – Rigid Aluminum Conduit (RAC)

d. Connection to Vibrating Equipment - Liquid-Tight Flexible Metallic Conduit (LFMC).

4. Fire Alarm Wiring

a. SLC and NAC – Electrical Metallic Tubing (EMT)

5. Where below grade conduit turns up above grade, finish floor, or foundation wall, the PVC conduit shall be changed to galvanized rigid steel conduit for approximately 6’ below grade to inside building. PVC conduit shall not turn up above finish floor, grade, or through foundation walls.

C. All raceways through walls and floors shall be provided with steel sleeves.

D. All exposed conduits shall be provided with escutcheon plates.

E. Cable Tray – Basket type wire mesh cable tray shall be provided above ceilings for low voltage cable management.

F. All conduits shall be minimum 3/4” in size with threaded or compression fittings.

G. Maximum length of flexible metal conduit will be six feet.

H. All conduits will receive insulated bushings or nylon throats.

I. Separate ground wires will be proved in each raceway.

J. Each branch circuit will be proved with dedicated neutral conductors.

K. Fire rated sleeve assemblies will be provided in all walls and floors for low voltage cabling.

L. Conductor sizes are based on copper unless indicated as aluminum or "AL". When aluminum conductor is substituted for copper conductor, size to match circuit requirements for conductor ampacity and voltage drop.

M. Raceway and boxes are located as indicated on Drawings, and at other locations where required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements.

N. Raceway Products:

1. Underground: Provide cast metal boxes or nonmetallic handhole.
2. In or Under Slab on Grade: Provide cast or nonmetallic metal boxes.
3. Outdoor Locations, Above Grade: Provide cast metal or nonmetallic outlet, pull, and junction boxes.
4. In Slab Above Grade: Provide metallic tubing and thickwall nonmetallic conduit. Provide cast metal boxes.
5. Wet and Damp Locations: Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
6. Concealed Dry Locations: Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
7. Exposed Dry Locations: Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

1.5 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.6 SUBMITTALS

A. Product Data: Submit for the following:

1. Flexible metal conduit.
2. Liquidtight flexible metal conduit.
3. Nonmetallic conduit.
4. Raceway fittings.
5. Conduit bodies.
6. Wireway.
7. Pull and junction boxes.
8. Handholes.

B. 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.

1.7 CLOSEOUT SUBMITTALS

A. 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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

B. Protect PVC conduit from sunlight.

1.9 COORDINATION

A. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.

B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. 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. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.

B. Wheatland Tube Company Product Description: Interlocked steel, aluminum construction.

C. Fittings: NEMA FB 1.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. AFC Cable Systems, Inc.
3. Alflex Inc.
4. Allied Tube & Conduit; a Tyco International Ltd. Co.
5. Anamet Electrical, Inc.; Anaconda Metal Hose.
6. Electri-Flex Co.
7. Manhattan/CDT/Cole-Flex.
8. Maverick Tube Corporation.
9. O-Z Gedney; a unit of General Signal.

B. Wheatland Tube Company Product Description: Interlocked aluminum construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.4 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.

B. Wheatland Tube Company Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel, compression type.

2.5 NONMETALLIC CONDUIT

A. Manufacturers:
1. Carlon Electrical Products.
2. AFC Cable Systems, Inc.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Arnco Corporation.
5. CANTEX Inc.
6. CertainTeed Corp.; Pipe & Plastics Group.
7. Condux International, Inc.
8. ElecSYS, Inc.
9. Electri-Flex Co.
10. Lamson & Sessions; Carlon Electrical Products.
11. Manhattan/CDT/Cole-Flex.
12. RACO; a Hubbell Company.
13. Thomas & Betts Corporation.

B. Product Description: NEMA TC 2; Schedule 80 PVC.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.6 WIREWAY

A. Manufacturers:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.

5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co., Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Product Description: General purpose type wireway.

C. Knockouts: Manufacturer's standard.

D. Size: One size larger than required by NEC.

E. Cover: Hinged cover.

F. Connector: Slip-in.

G. Fittings: Lay-in type with removable top, bottom, and side; captive screws.

H. Finish: Rust inhibiting primer coating with gray enamel finish.

2.7 OUTLET BOXES

A. Manufacturers:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co., Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet 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 or cast feralloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

E. Wall Plates for Finished Areas: As specified in Section 26 27 26.

F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.8 PULL AND JUNCTION BOXES

A. Manufacturers:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co., Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal 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 or Cast aluminum.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

E. In-Ground Cast Metal Box: NEMA 250, Type 6, inside flanged, recessed cover box for flush mounting:
1. Material: Galvanized cast iron or Cast aluminum.
2. Cover: Smooth cover with neoprene gasket and stainless steel cover screws.
3. Cover Legend: "ELECTRIC".

F. Concrete composite Handholes: Die-molded, concrete composite hand holes:
1. Conduit Entrance: Field core bored conduit entrance or each side.
2. Cover: Glass-fiber concrete composite. Weatherproof cover with nonskid finish.
3. Provide solid bottoms and gasketed cover.

2.9 SLEEVES

A. Sleeves for Conduit, Cable Tray and Wiring Through Non-fire Rated Floors: Steel pipe.

B. Sleeves for Conduit, Cable Tray and Wiring Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe.

C. Sleeves for Conduit, Cable Tray and Wiring Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

2.10 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.
3. Substitutions: Not 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.

2.11 FIRE STOPPING

A. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.

B. Foam Firestopping Compounds: Multiple component foam compound.

C. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.

D. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.

E. 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.

F. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.

G. Firestop Pillows: Formed mineral fiber pillows.

PART 3 EXECUTION

3.1 EXAMINATION

A. The drawings are generally indicative of the work to be performed but do not indicate all bends, fittings, boxes and specialties which may be required or the exact locations affecting all the work. Contractor shall arrange the work accordingly, and furnish such fittings as may be required to meet such conditions at no additional cost to the Owner, and arrange all vertical runs of conduit to clear beams, ductwork, mechanical equipment, and other obstructions.

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. All concealed conduit shall be placed in walls, floors, ceilings, or slabs at the proper time in accordance with the progress of meeting schedules and shall not delay the structural work unnecessarily. Conduits embedded in concrete shall be blocked and braced in place by use of adequate conduit separators to prevent displacement during pouring of the concrete. Where conduit interferes with structural steel, steel reinforcement, or in the opinion of the Engineer occupies too much space in the slab, the conduits shall be rearranged or installed exposed as directed by the Design Professional. No additional payment will be made for such rearrangement of conduit whether or not additional conduit or fittings might be required.

B. Conduit wall seals with water stops shall be installed in outside walls below grade for all incoming or outgoing underground conduit emerging directly into the building area. The conduit wall seals shall have a pressure ring and sealing grommet to ensure a watertight installation.

C. Exposed service entrance conduits and main feeder conduits shall be identified using stenciled letters at intervals not to exceed 20 feet. Size of letters shall be equal to ½ the diameter of the conduit or 2 inches, whichever is less.

D. Conduit joints shall be made up tight using a pipe wrench. Channel lock pliers will not be permitted, and unions shall be used as necessary to aid in the installation. Conduits shall be square and the ends reamed smooth after threading to prevent injury to conductors. Conduit joints in concrete or exposed to weather or damp locations shall be drawn up tight and coated with insulating paint before casting in concrete or painting exposed conduit system.

E. Field bending of polyvinyl chloride conduit shall be made with appropriate equipment. No torches or flame-type device shall be used.

F. When joints are to be made with polyvinyl chloride conduit, the conduit shall be cut with a fine-tooth saw and deburred. Conduit ends shall be wipe clean of dust, dirt, and shavings and shall be dry. A solvent cement shall be applied to bond the joint. The joint should be watertight.

G. Polyvinyl chloride conduit shall be installed in accordance with manufacturer's specifications and recommendations.

H. All underground conduit shall be concrete-encased unless otherwise noted on the drawings or directed by the Engineer. No conduit shall be concealed or encased until the Engineer has reviewed the work for proper installation and accurate placement.

I. The Contractor shall be responsible for all excavating, draining, trenches, forming of duct assembly and protective concrete envelop, backfilling, and removal of excess earth.

J. Underground conduit shall be installed with a minimum 3" per 100 foot downward slope for drainage. Drains shall be provided at all low points.

K. Bends and turns shall be made using long sweeps. Ninety-degree bends will be used only where required and shall be kept at a minimum.

L. All rigid metal conduit risers shall be protected with two coats of a Bitumastic compound before concrete is poured from a point 12" below grade to a point not less than 6" above grade or surface of concrete. All stub-ups shall extend upward with one length of rigid metal conduit until after concrete is poured to assure vertical alignment.

M. All underground conduit runs for voltages less than 600 volts shall be at least 48" below grade and shall have a minimum conduit separation of 3".

N. All underground conduit runs for voltages over 600 volts shall be at least 48" below grade and shall have a minimum conduit separation of 6". Conduit shall have a minimum 6" concrete cover on all sides.

O. All underground conduit runs shall be rodded and a mandrel drawn through followed by a swab to clean out any obstructions which may cause cable abrasions. The mandrel shall be 12" in length and the diameter ½" less than the inside diameter of the conduit.

P. 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. Arrange raceway supports to prevent misalignment during wiring installation. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

B. 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.

C. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

D. Do not attach raceway to ceiling support wires or other piping systems.

E. Construct wireway supports from steel channel specified in Section 26 05 29.

F. Route conduit in and under slab from point-to-point.

G. Maximum Size Conduit in Slab Above Grade: 3/4 inch. Do not cross conduits in slab.

H. Cut conduit square using saw or pipe cutter; de-burr cut ends. Bring conduit to shoulder of fittings; fasten securely.

I. 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.

J. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

K. 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 hydraulic one-shot bender to fabricate bends in metal conduit larger than 2 inch size.

L. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

M. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

N. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

O. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

P. 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.

Q. Close ends and unused openings in wireway.

R. Conceal all conduit unless indicated otherwise, within finished walls, ceilings, floors, and existing construction. Keep raceways at least twelve inches away from parallel runs of flues, steam, and hot water pipes. Install raceways level and square and at proper elevations.

S. Elevation of Raceway: Where possible, install horizontal raceway runs above all piping, and mechanical ducts tight to ceiling.

T. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

U. Install all raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Run exposed, parallel, or banked raceways together.

V. Communication System Raceways 2-Inch Trade Size and Smaller: In addition to the above requirements, install raceways 2-inch and smaller trade size in maximum lengths at 100 feet and with a maximum of two 90 deg. bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.

W. All conduits shall be securely supported by individual ring hangers and rods, steel trapeze hangers or galvanized malleable iron pipes fastened to concrete slabs, beams or bar joists or from beam clamps attached to the structural members of the building.

X. The arrangement of all conduits and the methods of fastening same shall be subject to the direction and approval of the Engineer and Architect. Power and branch circuit conduits shall be installed so that not more than the equivalent of three 90 degree bends occur in any one run. If a greater number of bends is required, a junction box shall be installed.

Y. Raceways, boxes, etc. above suspended ceiling shall be supported directly from structure, independent of ceiling system, duct, piping, or other work.

Z. All metal conduit enclosures and raceways for conductors shall be mechanically joined to form a continuous electrical conductor, and shall be so connected to all electrical boxes, fittings, and cabinets as to provide effective electrical continuity and firm mechanical assembly.

3.5 INSTALLATION - BOXES

A. Outlet boxes to be furnished and installed by this Contractor shall consist of the various types of outlet boxes required for wiring devices, lighting fixtures and all other equipment as required for the electrical work. The extent of the outlet boxes shall be as shown on the drawing and as required. Boxes shall be manufactured by Steel City or approved equal.

B. The exact location of outlets shall be obtained from the drawings of interior details and finishes. In locating outlets, caution shall be taken to allow for overhead pipes, ducts, variations in arrangement, thickness of finish window trim, paneling, door swings, and other architectural construction. All lighting fixture outlets shall be located symmetrically within areas. Any inaccuracy in locating outlets shall be corrected without additional expense to the Owner. Any condition that would place an outlet box in an unsuitable location, such as a molding or break in wall finish shall be referred to the Architect for a more desirable location. All outlet boxes shall

be securely fastened. Exposed outlet boxes shall be attached to permanent inserts or lead anchors with machine screws. All unused openings in outlet boxes shall be closed with knockout closers manufactured for that purpose.

C. Blank plates shall be installed on the outlet boxes on which no apparatus is installed, or if the apparatus installed does not provide a suitable cover for box.

D. Contractor shall submit a schedule of installation heights for coordination and approval by the Design Professional prior to final roughing-in.

E. Contractor shall be responsible that locations of outlets do not interfere with mechanical construction or architectural features.

F. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings and as specified in section for outlet device.

G. Adjust box location up to 10 feet prior to rough-in to accommodate

H. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

I. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

J. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

K. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

L. 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.

M. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

N. Install stamped steel bridges to fasten flush mounting outlet box between studs.

O. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

P. Install adjustable steel channel fasteners for hung ceiling outlet box.

Q. Do not fasten boxes to ceiling support wires or other piping systems.

R. Support boxes independently of conduit.

S. Install gang box where more than one device is mounted together. Do not use sectional box.

T. Install gang box with plaster ring for single device outlets.

3.6 STUB-UP CONNECTIONS

A. Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor.

3.7 FLEXIBLE CONNECTIONS

A. Use short length of flexible conduit for equipment subject to vibration, noise transmission or movement; and for all motors, transformers, dimmer panels/racks, and light fixtures. Use liquidtight flexible conduit in wet locations, inside air handling units, and all pump motors. Install separate ground conductor across flexible connections.

3.8 FITTINGS

1. All couplings and fittings for EMT shall be steel, contain nylon insulated throats and shall be raintight – either the gland and ring compression type or the stainless steel multiple point locking type, as manufactured by Thomas & Betts or approved equal. Fittings using sets of screws or indentations as a means of attachment will not be permitted.
2. Locknuts, bushings and other fittings for standard rigid conduit shall be made of steel or malleable iron; changes in direction or runs shall be made with symmetrical bends of cast metal fittings as manufactured by Crouse-Hinds or approved equal.
3. Raceways crossing expansion joints shall be provided with suitable expansion fittings.
4. Where rigid conduit is installed in a cabinet, junction box, pull box, or auxiliary gutter, the conductors shall be protected by a nylon insulated metallic bushings as manufactured by Thomas & Betts or approved equal. Locknut shall be installed outside the enclosure. Conduit bushings 1 ½" and larger shall be provided with a copper grounding lug with pressure type wire terminal.

3.9 INSTALLATION OF CONCEALED CONDUIT

1. Conduit work shall be concealed in all finished portions of the building. Where conduits are to be imbedded in concrete, they shall be placed so as not to interfere with the proper placement of the reinforcing bars.
2. Conduit shall be installed so as not to damage structural members. The approval of the Design Professional will be required to run conduit through columns, beams, or structural members.
3. Horizontal or crossruns in building-type partitions or side walls shall be avoided. All conduit to outlets in building-type partitions shall be run down from ceiling or up from slab into the partition. Conduit shall be run in the slab parallel to the partition, a minimum of 6" before making turn-up.

3.10 INSTALLATION OF EXPOSED RACEWAYS

1. Exposed, raceways, where permitted, and extensions from concealed conduit shall be neatly run, parallel with or at tight angles to the walls of the building. Where connection to overhead exposed raceways are required to be run down walls, vertical run of conduit shall be concealed within the new or existing wall to switchlegs, receptacles, panelboards, etc.
2. Exposed raceways shall be supported from ceilings or walls approved hangers, ceiling trapeze, clamps or clips fastened by machine screws to expansion sleeves, inserts or lead anchors. Conduit shall be supported on each side of bends. Spacing of clamps of hangers for supporting conduit from ceiling or walls shall not be greater than 5' apart.

3. Connections to motor terminal boxes shall be made by the use of flexible steel conduit not to exceed 18” in length, and shall be of the same size as the conduit to which it connects, grounded per N.E.C. requirements.

3.11 GROUDING

1. Electrically ground raceways and ensure continuous electrical conductivity.

3.12 SLEEVES

1. Exterior watertight entries: Seal with mechanical sleeve seal.
2. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
3. Install sleeves 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.

3.13 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified in Section.

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.

3.14 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused openings in boxes.

3.15 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION

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SECTION 26 09 13

POWER METERING SYSTEM

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SECTION 26 09 13

POWER METERING SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section Includes:
1. Power meters and communication.
2. Meter to be remote mounted in separate enclosure to minimize the physical size of the switchboards.
3. Provide all communication wiring to the building automation system.
4. Coordinate with the Controls Contractor to interface the meter with the building automation system.

1.3 REFERENCES

A. National Electrical Manufacturers Association:
1. IEEE C37.90.1.
2. IEC687
3. ANSI C12.201
4. NEMA
5. UL

1.4 SUBMITTALS

A. Shop Drawings: Indicate dimensioned drawings of control system components and accessories.

1. One Line Diagram: Indicating system configuration indicating panels, number and type of switches or devices.

2. Include typical wiring diagrams for each component.

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.

1.5 CLOSEOUT SUBMITTALS

A. 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.

B. Operation and Maintenance Data:

1. Submit manufacturer’s published installation instructions and operating instructions.
2. Recommended renewal parts list.

1.6 QUALIFICATIONS

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

1.7 PRE-INSTALLATION MEETINGS

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

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept components on site in manufacturer’s packaging. Inspect for damage.

B. Protect components by storing in manufacturer’s containers indoor protected from weather.

1.9 WARRANTY

A. Furnish one year manufacturer warranty for components.

1.10 APPROVED MANUFACTURER AND SUBSTITUTIONS

A. Approved manufacturer’s:

1. GE (EPM6000)
1. Square-D
2. Electro Industries

PART 2 PRODUCTS

2.1 POWER METERS

A. The meter shall be UL listed and CE marked.

B. Power meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems.

1. Meter shall support 3 element wye, 2.5 element wye, 2 element delta, 4 wire delta systems.
2. The meter shall accept universal voltage input.
3. Surge withstand shall conform to IEEE C37.90.1
4. The meter shall be user programmable for voltage range to any PT ratio.
5. Meter shall accept a burden of up to .36VA per phase, Max at 600V, 0.014VA at 120 Volts.
6. The meter shall accept a voltage input range of up to 416 Volts Line to Neutral, and a range of up to 721 Volts Line to Line.
7. Meter shall accept a current reading of up to 11 amps continuous.

C. Power meter shall use a dual input method for current inputs. Method one shall allow the CT to pass directly through the meter without any physical termination on the meter, ensuring the meter cannot be a point of failure on the CT circuit. The second method shall provide additional termination pass-through bars, allowing the CT leads to be terminated on the meter. The meter must support both termination methods.

1. Fault Current Withstand shall be 100 Amps for 10 seconds, 300 Amps for 3 seconds, and 500 Amps for 1 second.
2. Meter shall be programmable for current to any CT ratio. DIP switches or other fixed ratios shall not be acceptable
3. Meter shall accept burden of 0.005VA per phase, Max at 11 Amps.
4. Meter shall begin reading at a 5mA pickup current.
5. Pass through wire gauge dimension of 0.177” / 4.5 mm shall be available.
6. All inputs and outputs shall be galvanically isolated to 2500 Volts AC.
7. The meter shall accept current inputs of class 10: (0 to 11) A, 5 Amp Nominal, and class 2 (0 to 2) A, 1A Nominal Secondary.

D. The meter shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC687 (class 0.2%) and ANSI C12.201 (Class 0.2%).

1. The meter shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral.
2. The meter shall provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.

3. The meter shall utilize 24 bit Analog to Digital conversion.

E. The meter shall include a three line, bright red, .56" LED display.

1. The meter shall fit in both DIN 92mm and ANSI C39.1 Round cut-outs.

2. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.

F. Power meter shall include virtual measurement upgrade packs, which shall allow user to future upgrade in the field without removing installed meter.

1. These virtual upgrade packs must be able to be updated without physically removing the installed meter.

2. Meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.

G. The meter shall include 2 independent communications ports, one in the back and one at faceplate, with advanced features.

1. One port shall be factory selectable and provide either:

a) 10/100BaseT Ethernet communication port via an RJ45 connection through the back plate.

b) The Ethernet port will support Modbus TCP.

2. The meter shall provide an optical IrDA port (through faceplate), as the second communication port, which shall allow the unit to be set up and programmed using a remote laptop without need for a communication cable.

H. The meter shall provide user configured fixed window or rolling window demand. This shall allow user to set up the particular utility demand profile.

1. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.

2. All other parameters shall offer max and min capability over the user selectable averaging period.

3. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.

I. The meter shall support power supply of 90 to 265 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available.

1. Meter power supply shall accept burden of 10VA max.

2. Meter shall provide upgrade rate of 100msec for Watts, VAR and VA. All other parameters shall be 1 second.

J. The meter shall have a standard 1-year warranty.

K. Power meter shall be able to be stored in (-40 to +85) degrees C.

1. Operating temperature shall be (-30 to +70) degrees C.
2. NEMA 12 faceplate rating shall be available for the power meter.

PART 3 EXECUTION

3.1 INSTALLATION

A. Mount the meter in a remote cabinet next to the switch gear.

B. Use only properly color coded, stranded wire. Install wire in conduit.

3.2 MANUFACTURER'S FIELD SERVICES

A. Furnish services for minimum of one day for check, test, and start-up.

3.3 ADJUSTING

A. Test each system component after installation to verify proper operation.

B. Test installation to confirm proper operation.

3.4 DEMONSTRATION

A. Demonstrate operation of the following system components: Meter.

B. Furnish 4 hours to instruct Owner's personnel in operation and maintenance of system. Schedule training with Owner, provide at least 14 days notice to Design Professional of training date.

END OF SECTION

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SECTION 26 09 23

LIGHTING AND BRANCH CIRCUIT CONTROL DEVICES

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SECTION 26 09 23

LIGHTING AND BRANCH CIRCUIT CONTROL DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section Includes:
1. Occupancy sensors.
2. Power pack relays.

1.3 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, Contractors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks.
5. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
6. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
7. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

1.4 SYSTEM DESCRIPTION

A. Where indicated on drawings or required by applicable code, provide automatic shutoff for lighting inside building larger than 5000 square feet. Control shutoff by method conforming to ICC IECC.

B. Where indicated on drawings or required by applicable code, provide automatic shutoff for lighting outside building. Control shutoff by method conforming to ICC IECC.

1.5 SUBMITTALS

A. Shop Drawings: Indicate dimensioned drawings of control system components and accessories.

1. One Line Diagram: Indicating system configuration indicating panels, number and type of switches or devices.
2. Include typical wiring diagrams for each component.
3. Provide AutoCAD drawing of the facility showing coverage patterns and technical data.

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.

1.6 CLOSEOUT SUBMITTALS

A. 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.

B. Operation and Maintenance Data:

1. Submit replacement parts numbers.
2. Submit manufacturer’s published installation instructions and operating instructions.
3. Recommended renewal parts list.

1.7 QUALIFICATIONS

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

1.8 PRE-INSTALLATION MEETINGS

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

1.9 DELIVERY, STORAGE, AND HANDLING

A. Accept components on site in manufacturer’s packaging. Inspect for damage.

B. Protect components by storing in manufacturer’s containers indoor protected from weather.

1.10 WARRANTY

A. Furnish five year manufacturer warranty for components.

1.11 EXTRA MATERIALS

A. Furnish five of each switch type.

B. Furnish five of each occupancy sensor type.

C. Furnish five of each photocell type.

1.12 OCCUPANCY DETECTION TECHNOLOGY REQUIREMENTS

A. The occupancy sensor system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

B. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.

C. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.

D. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Ultrasonic which both looks for occupant motion and listens for sounds indicating occupants.

1.13 OCCUPANCY SENSOR OPERATION REQUIREMENTS

A. Sensors shall offer a minimum on timer of at least 15 minutes, in order to prevent all cycling of lamps before they have burned for the lamp manufacturers minimum recommended time period. This timer shall be in addition to the regular occupancy time delay that keeps lights on after last detected occupancy. User shall be able to disable/enable and change the value of this timer.

B. Sensors shall utilize an occupancy time delay that keeps lights on after last detected occupancy. Factory default setting of the occupancy time delay shall be 10 minutes. Sensors with a longer factory default setting shall not be permitted as they greatly restrict energy savings potential.

C. Manual adjustment to the occupancy time delay so as to increase it shall be accommodated, but shall not be allowed unless a calculation showing the resulting energy savings loss is presented to the building owner and specifying engineer.

D. Automatic adjustments to the occupancy time delay shall only be permitted if the controlling algorithm maximizes both lamp life and energy savings. For example a shorter more energy saving time delay setting shall only be allowed if the resulting lamp life is also improved.

E. Installer, in accordance with manufacturer’s recommendation, shall determine final sensor location. All sensors shall be factory calibrated for optimum performance for its installed PIR lens, and shall not require initial or subsequent field adjustment of detection sensitivity.

F. All sensor setting adjustments shall be digital and made using a push-button. Dip switches, analog dials, and/or the need for tools of any kind shall not be accepted.

G. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

1.14 MISCELLANEOUS REQUIREMENTS

A. All steps in sensor manufacturing process shall occur in the USA; including population of all electronic components on circuit boards, soldering, programming, wiring, and housing. Manufacturing facility must be ROHS compliant.

B. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.

C. All applicable products must be UL / CUL Listed or other acceptable national testing organization.

D. Sensors shall have a 5 year warranty.

1.15 APPROVED MANUFACTURER AND SUBSTITUTIONS

A. Approved manufacturer's:

1. Sensor Switch
2. Wattstopper
3. Hubbell
4. Leviton
5. Lutron

PART 2 PRODUCTS

2.1 WALL SWITCH OCCUPANCY SENSORS – SMALL AREAS

A. Sensor shall provide wall-to-wall PIR detection such that small hand motions are detected out to 20 ft (6.10 m).

B. In areas with periodic or permanent obstruction to a sensor's field of view, sensors that utilize dual technology (PIR/Ultrasonic) detection shall be used.

C. For applications requiring independent control of two loads, a sensor with two dual relays and dual override switches shall be required. Each relay shall have independent programmable occupancy time delays.

D. Sensors shall be capable of switching both 120 VAC and 277 VAC and run off of 50/60 Hz power. A version capable of switching 347 VAC shall also be available. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load.

E. Sensor shall recess into single gang switch box and fit a standard GFI opening.

F. Sensor shall meet NEC grounding requirements by providing a dedicated ground connection and intrinsically grounding through its mounting strap.

G. Line and load wire connections shall be interchangeable, such that installer cannot make an improper connection to a line/load in a manner that will cause malfunction or damage to the sensor.

H. Sensor shall not require a neutral connection regardless of number of poles and/or detection technology (only exception is versions with lighted push-buttons).

I. Sensor shall not allow any leakage of current to pass to the load when sensor is in the unoccupied (off) condition. Sensor shall not require a minimum load to be connected in order to function.

J. Sensor shall have optional features for photocell/daylight override, vandal resistant lens, low temperature/high humidity operation.

K. All sensor settings, including time delay and photocell settings shall be digital and accessible for adjustment via a push-button without requiring removal of cover plate or tools of any kind.

L. Wall Switch sensors shall have field programmable adjustments for selecting operational modes, occupancy time delays, minimum on time, and photocell set-point as applicable.

M. All models shall be capable of both Auto-On and Manual On operation.

N. All models shall be capable of a “Reduced Turn On” operation where the initial PIR turn on level is higher in order to eliminate PIR from reflective surfaces from being detected. PIR shall be returned to normal levels upon initial PIR detection.

O. All models shall have a “Predictive Off” mode where user can manually turn the lights off when leaving the room and still have them come on automatically when they return to space.

P. All models shall be capable of disabling override switch.

2.2 WALL SWITCH OCCUPANCY SENSORS – LARGE AREAS

A. Sensor shall provide wall-to-wall PIR detection such that small hand motions are detected out to 40 ft (12.19 m).

B. In areas with periodic or permanent obstruction to a sensor’s field of view, sensors that utilize dual technology (PIR/Ultrasonic) detection shall be used.

C. For applications requiring independent control of two loads, a sensor with two dual relays and dual override switches shall be required. Each relay shall have independent programmable occupancy time delays.

D. Sensors shall be capable of switching both 120 VAC and 277 VAC and run off of 50/60 Hz. A version capable of switching 347 VAC shall also be available. Load ratings shall be 13A each pole, ¼ HP motor load.

E. Sensor shall meet NEC grounding requirements by providing a dedicated ground connection and intrinsically grounding through its mounting strap.

F. Line and load wire connections shall be interchangeable, such that installer cannot make an improper connection to a line/load in a manner that will cause malfunction or damage to the sensor.

G. Sensor shall not require a neutral connection regardless of number of poles and/or detection technology.

H. Sensor shall not allow any leakage of current to pass to the load when sensor is in the unoccupied (Off) condition. Sensor shall not require a minimum load to be connected in order to function.

2.3 LOW VOLTAGE OCCUPANCY SENSOR

A. The installing contractor shall install one or more sensors with PIR coverage areas that cover the entire space and all entrance points. Exact placement and quantity required shall be per manufacturer's best practice recommendations.

B. In areas with periodic or permanent obstruction to a sensor's field of view, sensors that utilize dual technology (PIR/Ultrasonic) detection shall be used.

C. Sensors shall utilize a digital PIR detector (dual element pyro-electric detector) component, so as to provide a high degree of RF immunity.

D. Sensors shall interconnect with other sensors and power/relay packs with class 2, three-conductor wire.

E. Sensors shall operate on 12 to 24 VAC or VDC and consume no more than 5 mA so that up to 14 sensors may be connected to a single power pack.

F. Upon initial power up, sensors must immediately turn on. Power packs may be wired on the line or load side of local switching and must not exhibit any delays when switch is energized.

G. Each designated zone shall contain one sensor with a SPDT class 2 auxiliary relay, providing an input to building automation system (BAS). All sensors in designated zone shall communicate to sensor with relay for status to BAS. Sensor relay coil shall energize in the unoccupied state to load share the low voltage current from power pack. Note that power pack must be installed on the Line side of the local toggle switch for auxiliary relay to work properly.

H. Sensors shall have test mode that temporarily shortens/disable all time delays (e.g., minimum on, occupancy, photocell transition, dimming rates) such that an installer can quickly test operation of sensor. Test mode shall time out and return sensor to normal operation should the installer forget to disable test mode after installation.

I. Sensors shall have optional features for on/off photocell control, automatic dimming control photocell, high/low occupancy based dimming, and usage in low temperature/high humidity environments.

2.4 POWER PACKS

A. Power packs shall accept and switch 120 or 277 VAC, be plenum rated, and provide class 2 power for up to 14 remote sensors.

B. Power pack shall securely mount to junction location through a threaded ½ inch chase nipple. Plastic clips into junction box shall not be accepted. All class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.

C. When required by local code, power pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

D. Power pack shall incorporate a Class 1 relay and an AC electronic switching device. The AC electronic switching device shall make and break the load, while the relay shall carry the current in the on condition. This system shall provide full 20 Amp switching of all load types, and be rated for 400,000 cycles.

E. Power packs shall be single circuit, or two circuits. Slave packs may be used to control additional circuits. When two circuit power packs, or slave packs are used, the power packs must be wired directly to circuit breaker. Otherwise, power packs may be wired on the line or load side of the local switch.

2.5 LINE VOLTAGE OCCUPANCY SENSORS

A. Sensors shall be self-contained and accept Class 1 wiring directly without the use of a power pack.

B. The installing contractor shall install one or more sensors with PIR coverage areas that cover the entire space and all entrance points. Exact placement and quantity required shall be per manufacturer’s best practice recommendations.

C. In areas with periodic or permanent obstruction to a sensor’s field of view, sensors that utilize dual technology (PIR/Ultrasonic) detection shall be used.

D. Sensors shall utilize a digital PIR detector (dual element pyro-electric detector) component, so as to provide a high degree of RF immunity.

E. Line and load wire connections shall be interchangeable, such that installer cannot make an improper connection to a line/load in a manner that will cause malfunction or damage to the sensor.

F. Multiple sensors controlling the same load shall be wired in parallel.

G. For applications requiring independent control of two loads, a sensor with two dual relays shall be required. Each relay shall have independent programmable occupancy time delays.

H. Dual relay sensors shall have an optional operational mode called “Alternating On” where when during unoccupied periods, one relay is always left closed (thus one load is always on). The particular relay that is left closed alternates each cycle so that the aging of the connected lamps is even.

I. Sensors shall be capable of switching both 120 VAC and 277 VAC and run off of 50/60 Hz power. A version capable of switching 347 VAC shall also be available. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor load.

J. Specific sensors capable of switching 5 Amps of two phase power (208/240 or 480 VAC) shall be available. These sensors shall always simultaneously switch both phases as per NEC guidelines.

K. Wall mounted sensors must be installed at 7 to 8 feet above the floor. Single and two circuit units shall be available.

L. High bay sensors controlling HID Bi-Level must incorporate a “Start to High” timer on initial power up to provide full light output for up to 20 minutes to prevent shortened lamp life.

M. Sensors shall have test mode that temporarily shortens/disable all time delays (e.g., minimum on, occupancy, photocell transition, dimming rates) such that an installer can quickly test operation of sensor. Test mode shall time out and return sensor to normal operation should the installer forget to disable test mode after installation.

N. Sensors shall have optional features for on/off photocell control, automatic dimming control photocell, high/low occupancy based dimming, and usage in low temperature/high humidity environments.

PART 3 EXECUTION

3.1 INSTALLATION

A. Mount switches, occupancy sensors, and photocells as indicated on Drawings, and as recommended by the manufacturer.

B. Use only properly color coded, stranded wire. Install wire sizes as indicated on Drawings. Install wire in conduit.

3.2 MANUFACTURER'S FIELD SERVICES

A. Furnish services for minimum of three days for check, test, and start-up.

3.3 ADJUSTING

A. Test each system component after installation to verify proper operation.

B. Test relays, contactors, and switches after installation to confirm proper operation.

C. Confirm correct loads are recorded on directory card in each panel.

3.4 DEMONSTRATION

A. Demonstrate operation of the following system components:

1. Operation of switches. Demonstrate for all zones.
2. Operation of each type of occupancy sensor. Demonstrate for all zones.
3. Operation of type of photocell. Demonstrate for all zones.

B. Furnish 4 hours to instruct Owner's personnel in operation and maintenance of system. Schedule training with Owner, provide at least 14 days notice to Design Professional of training date.

END OF SECTION

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EXPANSION OF LUTRON QUANTUM LIGHTING CONTROLS

PART 1- GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section Includes:
1. Expansion of the existing High School Building Lutron Digital-Network Lighting Control System.
2. Provide networked interface back to the existing system either through Lutron dedicated network or through the building's information technology infrastructure.
3. Provide all required modifications to the existing system to monitor and control the new lighting control system components.
4. Provide all required Quantum hubs to communicate back to the existing system.
5. Provide low voltage wall stations to locally control all of the individual branch circuits. The wall stations will be located in the East Field House.

1.3 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE).
1. C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

B. ASTM International (ASTM)
1. D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight.
2. G21-96 (2002) - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
3. G22-76 (1996) - Standard Practice for Determining Resistance of Plastics to Bacteria.

C. Canadian Standards Association (CSA)
1. CSA C22.2 # 14 Industrial Control Equipment
2. CSA C22.2 # 184 Solid-State Lighting Controls
3. CSA C22.2 # 156 Solid-State Speed Controls
4. CSA C22.2 # 42.1-00 Cover Plates for Flush Mounted Wiring Devices

5. CSA C22.2 # 42-99 General Use Receptacles
6. CSA C22.2 #. 74 – Electronic Ballast Standard
7. CSA 22.2 # 223 - Power Supplies with Extra-Low-Voltage Class 2 Outputs.

D. International Electrotechnical Commission
1. (IEC) 801-2 Electrostatic Discharge Testing Standard.
2. IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
3. IEC/EN 55014-1 (2000) - Emission Test for Electrical Motor-Operated and Thermal Appliances for Household and Similar Purposes, Electrical Tools and Similar Electrical Apparatus.
4. IEC/EN 61000-3-2 (2000) - Limits for Harmonic Currents Emissions.
5. IEC/EN 61000-3-3 (1995) - Limitation of Voltage Fluctuations and Flicker.
6. IEC/EN 55014-2 (1997) - Immunity Test for Household Appliances Electrical Tools and Similar Electrical Appliances.
7. IEC/EN 60335-1 (2004) - Household and Similar Electrical Appliances - General Requirements.
8. IEC/EN 60335-2-97 (2002) - Household and Similar Electrical Appliances - Particular Requirements for Drives for Roller Shutters, Awnings, Blinds, and Similar Equipment.

E. International Organization for Standardization (ISO):
1. 9001:2000 – Quality Management Systems.

F. National Electrical Manufacturers Association (NEMA)
1. WD1 (R2005) - General Color Requirements for Wiring Devices.
2. WD6 – Dimensional Specifications.
3. Ballast standards

G. Underwriters Laboratories, Inc. (UL):
1. 94 – Flammability Rating
2. 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
3. UL498 – Standard for Attachment Plugs and Receptacles.
4. 508 (1999) - Standard for Industrial Control Equipment.
5. UL514C – Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers.
6. 916 – Energy Management Equipment.
7. 924 (2003) - Emergency Lighting and Power Equipment
8. 935 (2005) - Fluorescent Ballasts
9. 1310 – Class 2 Power Units.
10. 1472 (1996) - Solid-State Dimming Controls.

H. National Fire Protection Association (NFPA) 701 (2004) - Standard Methods of Fire Tests for Flame Propagation.

1.4 SYSTEM DESCRIPTION

A. Quantum includes computer-based software that provides control, configuration, monitoring and reports. System includes:
   1. Lighting Management Panel.
   2. Quantum Manager - light management computer and software.
   3. Power interfaces and power modules.
   4. Low voltage wall stations and control interfaces and sensors.

1.5 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. Mounting dimension requirements for each product and mounting condition.

C. Samples:
   1. Samples showing available color and finish selections for controls.

D. Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.

E. Sequence of Operation to describe how each area operates and how any building wide functionality is described.

F. Quality Control Submittals:
   1. Test Reports: Indicating compliance with specified fabric properties.
   2. Certification: Morton International Laboratory Report for PVC coated fabrics and bacterial and mildew resistance.

1.6 CLOSEOUT SUBMITTALS

A. 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.

1.7 QUALITY ASSURANCE

A. Lighting control system components:
   1. Listed by UL specifically for the required loads. Provide evidence of compliance upon request.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Include installation, programming, and maintenance instructions.

1.9 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature:
      a. Lighting Control System: 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.

B. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.10 COORDINATION

A. Coordinate pre-wiring of system utilizing manufacturer’s approved low voltage wiring to each device/equipment location.

1.11 WARRANTY

A. Provide Manufacturer’s 8 Year Limited Parts Warranty and 2 Year Labor Coverage :

1.12 MAINTENANCE MATERIAL SUBMITTALS

A. Make ordering of new equipment for expansions, replacements, and spare parts available to end-user, qualified dealer or installer.

B. Make new replacement parts available for minimum of 10 years from date of manufacture.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Lutron Electronics Co., Inc. – System: Lutron Quantum

2.2 GENERAL

A. Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F) and 90 percent non-condensing relative humidity.

B. Designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.

2.3 RELAY PERFORMANCE REQUIREMENTS

A. Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of relay.

B. Design and test relays to withstand line-side surges without impairment to performance.

1. Panels: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41 and per IEC 61000-4-5 surge requirements.
2. Other power handling devices: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41.

C. Power failure memory relay recovery:
1. When power is interrupted and subsequently returned, within 3 seconds lights will automatically return to same levels prior to power interruption.

D. Non-dim circuits to meet the following requirements:
1. Rated life of relay at full load: Minimum 1,000,000 cycles.
2. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.

2.4 ENERGI SAVR NODE LIGHTING CONTROL MODULE

A. Softswitch Switching Lighting Control Module:
1. Product: QSN
2. Mechanical:
   a. Listed to UL 508 (United States) as industrial control equipment. CSA (Canada) certified, or NOM (Mexico) approved as applicable.
   b. Delivered and installed as a [UL] [CSA] listed factory assembled panel.
   c. Panels passively cooled via free-convection, unaided by fans or other means.
3. Surface mounted
4. Switching:
   a. Rated life of relay: Minimum 1,000,000 cycles.
   b. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
   c. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
   d. Module to integrate up to 4 individually controlled zones, each with a capacity of up to 16 amps, of high in-rush lighting load (magnetic fluorescent ballast, electronic fluorescent ballast, incandescent, magnetic low-voltage, electronic low-voltage, neon/cold cathode and motor loads).
   e. Utilize air gap off – activated when user selects “off” at any control to disconnect the load from line supply.
5. Connection without interface to wired:
   a. Occupancy sensors
   b. Daylight sensors
   c. IR receivers for personal control
6. Capable of being controlled via wireless sensors and controls
7. Connects to Lighting Management Panel via RS485.
8. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
9. Contact Closure Input
   a. Directly accept contact closure input from a dry contact closure or solid-state output without interface to:

1) Activate scenes
   a) Scene activation from momentary or maintained closure
2) Enable or disable afterhours
   a) Automatic sweep to user-specified level after user-specified time has elapsed
   b) System will provide occupants a visual warning prior to sweeping lights to user-specified level
   c) Occupant can reset timeout by pressing a button on a control station
3) Activate or deactivate demand response (load shed)
   a) Load shed event will reduce lighting load by user-specified amount

10. Emergency Contact Closure Input
    a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 Listed Emergency Lighting Interface, security system or fire alarm system
    b. Allow configurable zone response during emergency state.
    c. Disable control operation until emergency signal is cleared.

2.5 LIGHTING MANAGEMENT PANEL

A. Provide Lighting Management Panel in a pre-assembled NEMA listed enclosure with terminal blocks listed for field wiring.

B. Enables Q-Admin Light Management software to control and monitor EcoSystem dimming ballast, EcoSystem modules, Power Panels, GRAFIK Eye QS, and Sivoia QS window treatments.
   1. Lighting Management Panel utilizes Ethernet connectivity to Q-Manager.
      a. Dedicated Network Environment is used to connect Q-Manager with Lighting Management Panels.

C. Integrate control station devices, power panels, shades, preset lighting controls, and external inputs into single customizable, multiple failsafe lighting control system, operable manually, automatically or through computer control.

D. Astronomical time clock.

E. Solar clock to track the position of the sun to control the shades to limit penetration of direct sunlight.

F. Maintains a backup of the programming in a non-volatile memory capable of lasting more than ten years without power.

G. BACnet Integration License for Lights
   1. Provide ability to communicate by means of BACnet IP communication to Lutron Quantum system from a user-supplied 10BASE-T or 100BASE-T Ethernet network.
   2. Lighting Management Panel shall have embedded BACnet stack. Lighting Control Systems requiring BACnet gateway to Energy Management System (EMS) or Building Management System (BMS) shall not be acceptable.
   3. Each Lighting Management Panel processor requires license for BACnet integration.
   4. Basic BACnet integration license for lights
      a. The BACnet integrator can command:
         1) Area light output

2) Area enable or disable afterhours mode
3) Area load shed level
4) Area load shed enable/disable

b. The BACnet integrator can monitor:
1) Area on/off status
2) Area occupancy status
3) Area fault
4) Area load shed status

2.6 POWER PANELS

A. Product: Lutron XP Series relay panels.

B. Mechanical:
1. Typically, electrical inspection is required for equipment installed in commercial buildings. Most inspectors will require a UL listing of products. The following statement ensures proper compliance for commercial applications.
2. Listed to UL 508 as industrial control equipment. CSA certified, or NOM approved as applicable.
3. To acquire UL or CSA listing on field assembled panels, a UL/CSA inspector must test the installed equipment on site. This will add costs to the project and could result in delays. Factory assembled panels are fully tested and UL/CSA listed when delivered to the site. These pre-assembled panels can be quickly installed and eliminate potential assembly errors in the field, saving installation costs.
4. Edit paragraph below retaining only those standards necessary to meet project requirements.
5. Delivered and installed as a [UL] [CSA] listed factory assembled panel.
6. If you remove components of the panel and reassemble it in the field, the UL listing is voided. To regain the UL listing the field assembled panel must be re-inspected by a UL inspector. The benefits of having the equipment pre-tested at the factory are lost. The following statement ensures panel integrity.
7. Field wiring accessible from front of panel without need to remove dimmer assemblies or other components.
8. Systems requiring forced air fan cooling require ongoing maintenance and increased energy usage for the life of the system. Natural convection eliminates this need and provides maintenance free cooling. The following statement ensures maintenance-free cooling of panels. If dimming panels are mechanically cooled, consider requiring the contractor to include a service contract to provide inspection and maintenance service on a semi-annual basis over the life of the equipment.
9. Panels passively cooled via free-convection, unaided by fans or other means.
10. Typically mis-wires and load shorts occur during initial startup. To prevent any damage to the equipment, jumpers need to be in place during startup. An additional benefit is that jumpers can be re-inserted to provide lighting in spaces in the unlikely event of a dimmer failure.
11. Ship panels with each dimmer in mechanical bypass position by means of jumper bar inserted between input and load terminals. Jumpers to carry full rated load current and be reusable at any time. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.

12. Utilize air gap off to disconnect the load from line supply.

2.7 LOW-VOLTAGE WALL STATIONS

A. System Wall Stations
   1. Allows controls of any devices part of the Lutron System.
   2. Product: Preset Lighting Controls with Zone Override.
   3. Electronics:
      a. Use RS485 wiring for low voltage communication.
   4. Functionality:
      a. Upon button press, LEDs to immediately illuminate.
      b. LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or the LEDs turn off if the button press was not processed.
      c. Allow for easy reprogramming without replacing unit.
      d. Replacement of units does not require reprogramming.
   5. Color:
      a. Custom color to be selected.
      b. Color variation in same product family: Maximum ΔE=1, CIE L*a*b color units.
      c. Visible parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.
   6. Provide faceplates with concealed mounting hardware.
   7. Engrave wall stations in English with appropriate button, zone, and scene engraving descriptions.
   8. Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
   9. Software Configuration:
      a. Customizable control station device button functionality:
         1) Buttons can be programmed to perform single defined action.
         2) Buttons can be programmed to perform defined action on press and defined action on release.
   10. Control station device LEDs to support logic that defines when it is illuminated:
      a. Scene logic (logic is true when all zones are at defined levels).
      b. Room logic (logic is true when at least one zone is on).
      c. Pathway (logic is true when at least one zone is on).
      d. Last scene (logic is true when spaces are in defined scenes).

2.8 ACCESSORIES

A. Emergency Lighting Interface; Lutron LUT-ELI
   1. Provides total system listing to UL924 when used with Lutron Quantum system.
   2. Senses all three phases of building power.
   3. Provides an output to power panels or Digital Ballast Interfaces if power on any phase fails and sends all lights controlled by these devices to [an emergency light level setting] [100 percent intensity]. Lights to return to their previous intensities when normal power is restored.
   4. Accepts a contact closure input from a fire alarm control panel.

2.9 WIRING DEVICE ACCESSORIES

A. Wall Plates
   1. Listed to UL 514C, CSA C22.2 #42.1-00
   2. Provide an adapter plate for proper device alignment and wall plate attachment.
   3. Product: Architectural style face plates: Vareo.

2.10 SOURCE QUALITY CONTROL

A. Perform full-function testing on all completed assemblies at end of line. Statistical sampling is not acceptable.

B. Perform full-function testing on 100 percent of all ballasts at the factory.

C. Audit burn-in at 40 degrees C (104 degrees F) ambient temperature of dimming assemblies and panels at full load for two hours.

D. Perform burn-in at 40 degrees C (104 degrees F) ambient temperature on 100 percent of all ballasts at the factory.

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 Q-Manager computer and Quantum Lighting Management Panels.

D. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

E. Define each relay's load type, assign each load to a zone, and set control functions.

F. Mount exterior daylight sensors to point due north with constant view of daylight.

G. Systems Integration:
   1. Contractor to coordinate meeting between Facility Representative, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures.

3.2 SERVICE AND SUPPORT

A. Startup and Programming
   1. Provide factory certified field service engineer to make minimum of six site visits to ensure proper system installation and operation under following parameters
      a. Qualifications for factory certified field service engineer:

1) Minimum experience of 2 years training in the electrical/electronic field.
2) Certified by the equipment manufacturer on the system installed.

b. Make first visit prior to installation of wiring. Review:
1) Low voltage wiring requirements.
2) Separation of power and low voltage/data wiring.
3) Wire labeling.
4) Lighting Management Panel locations and installations.
5) Control locations.
6) Computer jack locations.
7) Load circuit wiring.
8) Network wiring requirements.
9) Connections to other equipment and other Lutron equipment.
10) Installer responsibilities.
11) Power Panel locations.

c. Make second visit upon completion of installation of Network Lighting Control System:
1) Verify connection of power wiring and load circuits.
2) Verify connection and location of controls.
3) Energize Lighting Management Panels and download system data program.
4) Address devices.
5) Verify proper connection of panel links (low voltage/data) and address panel.
6) Download system panel data to dimming/switching panels
7) Check dimming panel load types and currents and supervise removal of by-pass jumpers.
8) Verify system operation control by control.
9) Verify proper operation of manufacturers interfacing equipment.
10) Verify proper operation of manufacturers supplied PC and installed programs.
11) Configure initial groupings of ballast for wall controls, daylight sensors and occupant sensors.
12) Initial calibration of sensors.
13) Obtain sign-off on system functions.

d. Make third visit to demonstrate and educate Owner's representative on system capabilities, operation and maintenance.

e. Remaining visits to be scheduled as required for the troubleshooting.

2. Startup
a. Q-Admin configuration
1) Naming and association of areas and lighting zones.

B. Training of customer representatives for Q-Admin.
1. Configuration Software used to make system programming and configuration changes
2. Control and Monitor
3. Green Glance

C. Tech Support
1. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

3.3 FIELD QUALITY CONTROL

A. Manufacturer Services
   1. Aim and Focus Visit
      a. Contractor to coordinate on-site meeting with Lighting Control System Manufacturer and Lighting Design Consultant to make required lighting adjustments to the system for conformance with the Lighting Design Consultant's original design intent.

3.4 CLOSEOUT ACTIVITIES

A. Training Visit
   1. Lighting Control System Manufacturer to provide 1 day 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.

3.5 DEMONSTRATION

A. Demonstrate proper operation and maintenance of control system to Owner.

3.6 MAINTENANCE

A. Capable of providing on-site service support within 24 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.

C. System Optimization Visit
   1. Lighting Control System Manufacturer to visit site 6 months and 12 months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.

END OF SECTION

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OUTDOOR SWITCHGEAR

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SECTION 26 11 18

OUTDOOR SWITCHGEAR

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 GENERAL

A. The pad-mounted gear shall be in accordance with the single-line diagram, and shall conform to the following specification.

B. The pad-mounted gear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, all completely factory-assembled and operationally checked. The interrupter switches and fuses shall be enclosed within an inner grounded steel compartment for electrical isolation and for protection from contamination. Switch terminals shall be equipped with bushings rated 600 amperes continuous, and fuse terminals and bus terminals shall be equipped with bushing wells rated 200 amperes continuous to provide for elbow connection. Bushings and bushing wells shall be mounted on the walls of the inner compartment and shall extend into termination compartments. A termination compartment shall be provided for each three-phase switch, each three-phase set of fuses, and each three-phase set of bus terminals.

C. Ratings

The ratings for the integrated pad-mounted gear shall be as designated below.
Nominal Voltage, kV: 14.4
Maximum Voltage, kV: 17.0
BIL Voltage, kV: 95
Short-Circuit
Peak Withstand Current, Amperes, Peak: 32,500
One-Second Short-Time Withstand Current, Amperes, RMS, Symmetrical: 12,500
MVA, Three-Phase Symmetrical, at Rated Nominal Voltage: 310
Main Bus
Continuous Current, Amperes: 600
Peak Withstand Current, Amperes, Peak: 65,000
One-Second Short-Time Withstand Current, Amperes, RMS, Symmetrical: 25,000

Three-Pole Interrupter Switches
Continuous Current, Amperes: 600
Load Dropping Current, Amperes: 600
Peak Withstand Current, Amperes, Peak: 65,000
One-Second Short-Time Withstand Current, Amperes, RMS, Symmetrical: 14,000
Three-Time Duty-Cycle Fault-Closing Current, Amperes, Peak: 36,400
Fuses
Maximum Current, Amperes: 200E

D. The short-circuit and three-time duty-cycle fault-closing ratings of switches, short-circuit rating of bus, and interrupting ratings of fuses shall equal or exceed the short-circuit ratings of the pad-mounted gear.

1.3 CERTIFICATION OF RATINGS

A. The manufacturer of the pad-mounted gear shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated assembly as rated.

B. The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure.

1.4 COMPLIANCE WITH STANDARDS AND CODES

A. The pad-mounted gear shall conform to or exceed the applicable requirements of the following standards and codes:

1. All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.
2. Article 710.21(e) in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.
3. All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.
4. UL Listing.

1.5 ENCLOSURE DESIGN

A. To ensure a completely coordinated design, the pad-mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances.

B. In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, corrosion resistance, and resistance to entry of foliage, animals, and airborne contaminants.

PART 2 CONSTRUCTION

2.1 INSULATORS

A. The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

1. Operating experience of at least 25 years under similar conditions.
2. Adequate leakage distance established by test per IEC Publication 507, “Artificial Pollution Test on High Voltage Insulators to be Used on AC Systems.”
3. Adequate strength for short-circuit stress established by test.
4. Conformance with applicable ANSI standards.
5. Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

2.2 HIGH-VOLTAGE BUS

A. Bus and interconnections shall consist of aluminum bar of 56% IACS conductivity.

B. Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted gear.

C. Bolted aluminum-to-aluminum connections shall be made with a suitable number of galvanized steel bolts, with two Belleville spring washers per bolt, one under the bolt head and one under the nut. Bolts shall be tightened to 50 foot-pounds torque.

D. Before installation of the bus, all electrical contact surfaces shall first be prepared by machine-abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

E. Tie bus, where furnished, shall consist of continuous, one-piece sections of aluminum bar with no intermediate splices. Flexible braid or cable shall not be used.

2.3 PROVISIONS FOR GROUNDING

A. A ground-connection pad shall be provided in each termination compartment of the pad-mounted gear.

B. The ground-connection pad shall be constructed of no less than 3/8 in.-thick steel. It shall be nickel plated and welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.

C. Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

D. A copper rod, connected to the ground-connection pad, shall be provided in each termination compartment for switches and bus. The rod shall have a diameter no less than 3/8-in. and extend across the full width of the compartment to allow convenient grounding of cable concentric neutrals and accessories, and shall have a short-circuit rating equal to that of the pad-mounted gear.

E. Continuous copper ground bus shall be provided across the full width of each termination compartment for fuses. For each fuse mounting, there shall be a ground ring made of 3/8 in.-diameter copper rod bolted to the ground bus and placed to allow convenient grounding of cable concentric neutrals and accessories. Ground rings and bus shall have a short-circuit rating equal to that of the pad-mounted gear.

2.4 BUSHINGS AND BUSHING WELLS

A. Bushings and bushing wells shall conform to ANSI/IEEE Standard 386.

B. Bushings and bushing wells shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

1. Operating experience of at least 15 years under similar conditions.
2. Adequate leakage distance for in-air application established by test per IEC Publication 507, “Artificial Pollution Test on High Voltage Insulators to be Used on AC Systems.”
3. Adequate strength for short-circuit stress established by test.
4. Conformance with applicable ANSI standards.
5. Homogeneity of the cycloaliphatic epoxy resin throughout each bushing or bushing well to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation.

C. Bushings and bushing wells shall be mounted in such a way that the semiconductive coating is solidly grounded to the enclosure.

D. Bushings rated 600 amperes continuous shall have a removable threaded stud so that the bushings are compatible with all 600-ampere elbow systems—those requiring a threaded stud as well as those that do not.

2.5 TERMINATION COMPARTMENTS

A. Termination compartments for switches shall have bushings, and termination compartments for fuses shall have bushing wells to permit connection of elbows. The bushings and bushing wells shall be mounted on the interior walls at a minimum height of 33 inches above the enclosure base.

B. Termination compartments for bus shall have bushing wells to permit connection of elbows. The bushing wells shall be mounted on the interior walls at a minimum height of 25 inches above the enclosure base.

C. Termination compartments for bushings rated 600 amperes continuous shall be of an adequate depth to accommodate two 600-ampere elbows mounted piggyback, encapsulated surge arresters or grounding elbows mounted on 600-ampere elbows having 200-ampere interfaces, or other similar accessory combinations without the need for an enclosure extension.

D. Termination compartments shall be provided with one parking stand for each bushing or bushing well. The parking stand shall be located immediately adjacent to the associated bushing or bushing well and shall accommodate standard feedthrus and standoff insulators, and other similar accessories.

E. Each termination compartment for a switch shall be equipped with a viewing window to allow visual inspection of interrupter switch blades to allow positive verification of switch position.

F. Each termination compartment for a set of fuses shall be equipped with a set of viewing windows to allow visual inspection of blown-fuse indicators.

2.6 ENCLOSURE

A. The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.

B. The basic material shall be 11-gauge hot-rolled, pickled and oiled steel sheet.

C. All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. The gas-metal-arc welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.

D. To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.

E. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.

F. The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.

G. Gasketing between the roof and the enclosure shall guard against entry of water and airborne contaminants and shall discourage tampering or insertion of foreign objects.

H. An internal steel-enclosed compartment shall encase the interrupter switches and fuses for electrical isolation and protection from contamination. The compartment shall have a galvanized steel sheet floor to exclude foliage and animals. The floor shall have screened drain vents to allow drainage if the enclosure is flooded. The top of this compartment shall be gasketed to provide sealing with the enclosure roof.

I. Insulating barriers of NEMA GPO3-grade fiberglass-reinforced polyester shall be provided for each interrupter switch where required to achieve BIL ratings. Additional insulating barriers of the same material shall isolate the tie bus (where furnished).

J. Full-length steel barriers shall separate adjoining termination compartments.

K. Lifting tabs shall be removable. Sockets for the lifting-tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be closed-cell to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

1. The enclosure shall be provided with an instruction manual holder.

2.7 DOORS

A. Doors shall be constructed of 11-gauge hot-rolled, pickled and oiled steel sheet.

B. Door-edge flanges shall overlap with door-opening flanges to discourage tampering or insertion of foreign objects.

C. Doors shall have a minimum of two extruded-aluminum hinges with stainless-steel hinge pins, and interlocking extruded-aluminum hinge supports for the full length of the door to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-nickel-plated steel, and shall not be externally accessible to guard against tampering.

D. Doors shall be hinged at the sides to swing open with minimum effort. Doors hinged at the top requiring significant effort to lift open shall not be allowed.

E. In consideration of controlled access and tamper resistance, each door (or set of double doors) shall be equipped with an automatic three-point latching mechanism.

1. The latching mechanism shall be spring-loaded, and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.

2. A pentahead socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.

3. The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches such that:

a. It shall not be possible to unlatch the mechanism until the padlock is removed, and

b. It shall not be possible to insert the padlock until the mechanism is completely latched closed.

F. Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.

G. Each door shall be provided with a zinc-nickel-plated steel door holder located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.

2.8 ROOF

A. The roof shall be constructed of 11-gauge hot-rolled, pickled and oiled steel sheet.

B. A heavy coat of insulating “no-drip” compound shall be applied to the inside surface of the center roof section to minimize condensation of the moisture thereon.

C. Roof sections over termination compartments shall be liftable and hinged to allow room for cable pulling during installation. Each roof section shall require minimal effort to open and close and shall have a retainer to hold it in the open position.

D. A mechanical interlock shall be provided to ensure that the roof sections over the termination compartments are closed and secured before allowing full engagement of the door latching mechanism.

E. Roof sections over high-voltage compartments shall be bolted to the enclosure with no exposed fasteners.

2.9 FINISH

A. Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

B. All exterior seams shall be filled and sanded smooth for neat appearance.

C. To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling before any protective coatings are applied. By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations.

D. After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the enclosure manufacturer’s finishing system shall satisfactorily pass the following tests:

1. 4000 hours of exposure to salt-spray testing per ASTM B 117 with:
    a. Underfilm corrosion not to extend more than 1/32 in. from the scribe, as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping); and
    b. Loss of adhesion from bare metal not to extend more than 1/8 in. from the scribe.
2. 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type Humidity Cabinet, with no blistering as evaluated per ASTM D 714.

3. 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB-313, with no chalking as evaluated per ASTM D 659, and no more than 10% reduction of gloss as evaluated per ASTM D 523.
4. Crosshatch-adhesion testing per ASTM D 3359 Method B, with no loss of finish.
5. 160-inch-pound impact, followed by adhesion testing per ASTM D 2794, with no chipping or cracking.
6. 3000 cycles of abrasion testing per ASTM 4060, with no penetration to the substrate.
7. Certified test abstracts substantiating the above capabilities shall be furnished upon request.

E. After the finishing system has been properly applied and cured, welds along the enclosure bottom flange shall be coated with a wax-based anticorrosion moisture barrier to give these areas added corrosion resistance.

F. A resilient closed-cell material, such as PVC gasket, shall be applied to the entire underside of the enclosure bottom flange to protect the finish on this surface from scratching during handling and installation. This material shall isolate the bottom flange from the alkalinity of a concrete foundation to help protect against corrosive attack.

G. After the enclosure is completely assembled and the components (switches, fuses, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish.

H. The finish shall be olive green, Munsell 7GY3.29/1.5.

2.10 CORROSION PROTECTION

A. To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc-nickel-plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

2.11 INTERRUPTER SWITCHES

A. Interrupter switches shall be enclosed in an inner steel compartment and shall be provided with bushings rated 600 amperes continuous to permit connection of elbows external to the switch compartment.

B. Interrupter switches shall have a three-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch three times against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.

C. Interrupter switches shall be operated by means of an externally accessible 3/4-in. hex switch-operating hub. The switch-operating hub shall be located within a recessed stainless-steel pocket mounted on the side of the pad-mounted gear enclosure and shall accommodate a 3/4-in. deep-socket wrench or a 3/4-in. shallow-socket wrench with extension. The switch-operating-hub pocket shall include a padlockable stainless-steel access cover that shall incorporate a hood to protect the padlock shackle from tampering. Stops shall be provided on the switch-operating hub to prevent overtravel and thereby guard against damage to the interrupter switch quick-make quick-break mechanism. Labels to indicate switch position shall be provided in the switch-operating-hub pocket.

D. Each interrupter switch shall be provided with a folding switch-operating handle. The switch-operating handle shall be secured to the inside of the switch-operating-hub pocket by a brass chain. The folded handle shall be stored behind the closed switch-operating-hub access cover.

E. Interrupter switches shall utilize a quick-make quick-break mechanism installed by the switch manufacturer. The quick-make quick-break mechanism shall be integrally mounted on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the switch-operating-hub speed.

F. Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.

G. Interrupter switch contacts shall be backed up by stainless-steel springs to provide constant high contact pressure.

H. Interrupter switches shall be provided with a single blade per phase for circuit closing, including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted. Interrupter switch blade supports shall be permanently molded in place in a unified insulated shaft constructed of the same cycloaliphatic epoxy resin as the insulators.

I. Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.

J. Key interlocks shall be provided to guard against opening the door(s) of fuse-termination compartment(s) unless all switches are locked open.

2.12 FUSES

A. Solid-Material Power Fuses

1. Solid-material power fuses shall utilize refill-unit-and-holder or fuse-unit-and-end-fitting construction. The refill unit or fuse unit shall be readily replaceable and low in cost.

2. Fusible elements shall be nonaging and nondamageable so it is unnecessary to replace unblown companion fuses following a fuse operation.

3. Fusible elements for refill units or fuse units, rated 10 amperes or larger, shall be helically coiled to avoid mechanical damage due to stresses from current surges.

4. Fusible elements that carry continuous current shall be supported in air to help prevent damage from current surges.

5. Refill units and fuse units shall have a single fusible element to eliminate the possibility of unequal current sharing in parallel current paths.

6. Solid-material power fuses shall have melting time-current characteristics that are permanently accurate to within a maximum total tolerance of 10% in terms of current. Time-current characteristics shall be available which permit coordination with source-side and load-side protective relays, automatic circuit reclosers, and other fuses.

7. Solid-material power fuses shall be capable of detecting and interrupting all faults, whether large, medium, or small (down to minimum melting current); under all realistic conditions of circuitry; and with line-to-line or line-to-ground voltage across the fuse. They shall be capable of handling the full range of transient recovery voltage severity associated with these faults.

8. All arcing accompanying solid-material power fuse operation shall be contained within the fuse, and all arc products and gases evolved shall be effectively contained within the exhaust control device during fuse operation.

9. Solid-material power fuses shall be equipped with a blown-fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.

2.13 HAZARD-ALERTING SIGNS

A. All external doors shall be provided with “Warning—Keep Out—Hazardous Voltage Inside—Can Shock, Burn, or Cause Death” signs.

B. The inside of each door shall be provided with a “Danger—Hazardous Voltage—Failure to Follow These Instructions Will Likely Cause Shock, Burns, or Death” sign. The text shall further indicate that operating personnel must know and obey the employer’s work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.

C. Termination compartments shall be provided with “Danger—Keep Away—Hazardous Voltage—Will Shock, Burn, or Cause Death” signs.

2.14 NAMEPLATES, RATINGS LABELS, AND CONNECTION DIAGRAMS

A. The outside of each door (or set of double doors) shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.

B. The inside of each door (or set of double doors) shall be provided with a ratings label indicating the following:

1. Overall pad-mounted gear ratings: nominal voltage, kV; maximum voltage, kV; BIL voltage, kV; power frequency, Hz; short-circuit peak withstand current, amperes, peak; short-circuit one-second short-time withstand current, amperes, RMS, symmetrical; and short-circuit MVA, three-phase symmetrical, at rated nominal voltage.

2. Main bus ratings: continuous current, amperes; peak withstand current, amperes, peak; and one-second short-time withstand current, amperes, RMS symmetrical.

3. Switch ratings: continuous current, amperes; load splitting current, amperes; load dropping current, amperes; peak withstand current, amperes, peak; one-second short-time withstand current, amperes, RMS, symmetrical; and three-time duty-cycle fault-closing current, amperes, RMS symmetrical and amperes, peak.

4. Fuse type and ratings: maximum current, amperes and interrupting current, amperes, RMS, symmetrical.

C. A three-line connection diagram showing interrupter switches, fuses, and bus along with the manufacturer's model number shall be provided on the inside of each door (or set of double doors), and on the inside of each switch-operating-hub access cover.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify service equipment is ready to be connected and energized.

3.2 INSTALLATION

A. Install service entrance conduits to building service entrance pad mount transformer.

END OF SECTION

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SECTION 26 12 00

PAD-MOUNTED TRANSFORMERS, LIQUID FILLED

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SECTION 26 12 00

PAD-MOUNTED TRANSFORMERS, LIQUID FILLED

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 0 – Bidding and Contract Requirements and Division 1 – General Requirements specification sections, apply to this Section.

1.2 REFERENCES

A. IEEE C37.47™ - Specifications for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses

B. IEEE C57.12.00™ - Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

C. IEEE C57.12.10™ – Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers: High Voltage, 34,500 GrdY/19,900 Volts and Below; Low Voltage, 480 Volts and Below.

D. ANSI C57.12.28 - Switchgear and Transformers, Pad-Mounted Equipment - Enclosure Integrity

E. IEEE C57.12.90™ - Standard Test Code for Liquid-Immersed Distribution Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers

F. IEEE C57.13™ - Requirements for Instrument Transformers

G. ANSI/IEEE 386 - Separable Insulated Connector Systems for Power Distribution Systems Above 600 V

H. ASTM D877 - Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

I. NEMA AB1 - Molded Case Circuit Breakers

J. CAN/CSA-C88-M90 - Electrical Power Systems and Equipment

1.3 SUBMITTALS

A. Submit shop drawings indicating outline dimensions, connection and support points, weight, specified ratings and materials.

B. Submit product data indicating standard model design tests and options.

C. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

A. Include procedures for sampling and maintaining fluid, maintaining unit, and replacing components.

1.5 QUALITY ASSURANCE

A. Manufacturer: Company specializing in distribution transformers with 10 years documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Square D Company.
B. Cooper.
C. ABB.
D. Siemens.
E. GE.
F. Culter-Hammer.

2.2 FLUID-FILLED PAD-MOUNTED TRANSFORMERS

A. The transformer shall be 500 kVA compartment type, self-cooled, for mounting on a pad and shall comply with the latest applicable standards.

B. The average temperature rise of the windings, measured by the resistance method, shall be 65°C and 55°C /65°C (as noted on drawings) when the transformer is operated at rated kVA output. The transformer shall be capable of being operated at rated load in a 30° C average, 40° C maximum ambient, as defined by IEEE C57.12.00 without loss of service life expectancy.

C. Coolant and insulating fluid shall be less flammable seed-oil based fluid as defined by the NEC and approved by FM (300ºC flashpoint/350ºC firepoint).

D. The high and low voltage compartments shall be located side by side, separated by a steel barrier. When facing the transformer, the low voltage compartments shall be on the right. Terminal compartments shall be full height, air-filled, with individual doors. The high voltage door fastenings shall not be accessible until the low voltage door has been opened.

E. The following accessories shall be provided as standard on all transformers:

1. Nameplate in low voltage compartment.
2. 1” upper filter press and filling plug

3. 1” Drain valve with sampling device.
4. Lightning arrester mounting provisions.
5. Tap changer with silver-plated stationary and movable contacts, for de-energized operation only, which is externally operable and padlockable.
6. The front of both compartments shall be removable to allow the transformer to be rolled or skidded into position over conduit stubs. ANSI tank grounding provisions shall be furnished in both compartments.
7. Dial type thermometer.
8. Magnetic liquid-level gauge.
9. Pressure vacuum gauge.
10. Pressure relief valve.
11. Pentahead bolts for compartment doors.

F. The transformer(s) shall be rated as shown on drawings, self cooled (ONAN). Primary voltage 12,470 delta. Secondary voltage 480/277 wye, 4-wire, 60 Hz with two 2-1/2% full capacity above normal and two 2-1/2% below normal taps. Impedance shall be manufacturer's standard impedance, ±7-1/2%. Basic impulse level of the primary winding shall be 95kV.

G. The transformer shall be of sealed-tank construction of sufficient strength to withstand a pressure of 7 psi without permanent distortion. The cover shall be welded and the handhole fastenings tamper-resistant. The transformer shall remain effectively sealed for a top oil temperature range of –5° C to 105° C. When required, cooling panels will be provided on the back and sides of the tank. Lifting eyes and jacking provisions will be provided.

H. Coils shall be wound with aluminum conductors.

I. All cores to be constructed of high grade, grain-oriented, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux is to be kept well below the saturation point.

J. The high voltage terminations and equipment shall be dead front.

K. HV dead front bushings shall be 600A, either universal wells or one-piece integrated for use with separable connectors. Bushings shall be externally clamped and front removable.

L. The low voltage bushings ($\leq$600V) shall be molded polymer, and provided with blade-type spade terminals with NEMA standard hole spacing arranged for vertical take-off. The low voltage neutral shall be an insulated bushing, grounded to the tank by a removable ground strap.

M. Provide a load break, gang operated, liquid immersed switch rated at 600A that is externally operable from the high voltage compartment through the use of a distribution hot-stick. Switch to be 4-position "sectionalizing" type for use on an extended radial or loop-feed system with feed-from-the-left, feed-from-the-right, isolated-from-either-side, or through-feed to both sides.

N. Provide bayonet type liquid immersed fuses that are externally replaceable with a hot-stick without opening the transformer tank.

O. Surge Protection - Provide three distribution class lightning arresters for surge protection. Arresters are to be mounted in the high voltage compartment.

P. Additional Accessories

1. Automatic pressure relief device (self-sealing with indicator).
2. Mounting provisions for low voltage current transformers and potential transformers.
3. Sudden pressure relay.
4. Key interlock to primary or secondary compartment door.
5. Bushing well inserts
6. Feed-thru inserts (Loop feed).
7. MOVE elbow arresters.

Q. Transformer shall be UL listed.

R. Testing - Tests shall be conducted in accordance with the provisions of IEEE C57.12.90 and shall include, as a minimum, the following tests:

1. Ratio
2. Polarity
3. Phase Rotation
4. No-Load Loss
5. Excitation Current
6. Impedance Voltage
7. Load Loss
8. Applied Potential
9. Induced Potential
10. QC Impulse Test

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that pads are ready to receive work.

B. Verify field measurements.

C. Verify that required utilities are available, in proper location and ready for use.

D. Beginning of installation means Contractor accepts conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install safety labels to NEMA 260.

3.3 FIELD QUALITY CONTROL

A. Perform NETA Visual and Mechanical Inspection

B. Perform NETA turns-ratio test on all no-load tap-changer positions and all load tap-changer positions. Verify that tap setting is as specified. Verify that winding polarities are in accordance with nameplate.

C. Perform NETA insulation power-factor/dissipation-factor tests on all windings and bushings.

3.4 ADJUSTING

A. Adjust primary taps so that secondary voltage is within 2% of rated voltage.

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SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

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SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Dry-type energy efficient transformers per NEMA TP1, with primary and secondary voltages of 600V and less and capacity ratings 15kVA through 750kVA.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code
B. NEMA ST20
C. UL 1561
D. NEMA TP1
E. NEMA TP2

1.4 SUBMITTALS

A. 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.

B. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

C. Suppliers asking consideration as an approved equal shall submit complete, warranted performance data and physical dimensions for similar transformers. Data shall be submitted for each size specified, and shall be received by the consultant engineer no less than 10 days prior to the bid due date for consideration.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of transformers.

1.6 STANDARDS

A. Transformers 750kVA and smaller shall be listed by Underwriters Laboratories.

B. Conform to the requirements of ANSI/NFPA 70.

C. Transformers are to be manufactured and tested in accordance with NEMA ST20.

D. Transformers losses shall conform to NEMA TP1 requirements

E. Transformers losses shall be tested in accord with NEMA TP2 procedures

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 20 years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. 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 MANUFACTURERS

1. Square-D
2. Cutler-Hammer
3. Siemens
4. GE

2.2 RATINGS INFORMATION

1. All insulating materials are to exceed NEMA ST20 standards and be rated for 220°C UL component recognized insulation system.

2. Transformers 15kVA and larger shall be 150°C temperature rise above 40oC ambient. Transformers 25kVA and larger shall have a minimum of 4 - 2.5% full capacity primary taps. Exact voltages and taps to be as designated on the plans or the transformer schedule.

3. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.

4. Transformers shall be low loss type with minimum efficiencies per NEMA TP1 when operated at 35% of full load capacity. Efficiency shall be tested in accord with NEMA TP2.

Single Phase		Three Phase	
kVA	Efficiency	kVA	Efficiency
15	97.7%	15	97.0%
25	98.0%	30	97.5%
37.5	98.2%	45	97.7%
50	98.3%	75	98.0%
75	98.5%	112.5	98.2%
100	98.6%	150	98.3%
167	98.7%	225	98.5%
250	98.8%	300	98.6%
333	98.9%	500	98.7%
		750	98.8%

5. The transformer(s) shall be rated as indicated on the drawings.

2.3 CONSTRUCTION

A. Transformer coils shall be of the continuous wound construction and shall be impregnated with nonhygroscopic, thermosetting varnish

B. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point to prevent core overheating. Cores for transformers greater than 500kVA shall be clamped utilizing insulated bolts through the core laminations to ensure proper pressure throughout the length of the core. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

C. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.

D. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degeasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.

2.4 SOUND LEVELS

A. Sound levels shall be warranted by the manufacturer not to exceed the following:
   1. 15 to 50KVA - 45dB; 51 to 150kVA - 50dB; 151 to 300kVA - 55dB; 301 to 500kVA - 60dB; 501 to 700kVA - 62dB; 701 to 1000kVA - 64dB; 1001 to 1500kVA - 65dB; 1501 to 2000kVA- 66dB

2.5 OPTIONAL ACCESSORIES

A. Provide weathershields for all exterior transformers.

B. Provide wall mounting brackets for all wall mounted transformers as indicated on the drawings.

C. Provide ceiling mounting brackets for all ceiling mounted transformers as indicated on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. 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, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure, unless otherwise noted.

C. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by manufacturer.

D. Mount floor-mounted transformers on vibration isolating pads suitable for isolating transformer noise from building structure.

E. Mount trapeze-mounted transformers as indicated on Drawings.

F. Install grounding and bonding.

3.3 FIELD QUALITY CONTROL

A. Perform NETA Visual and Mechanical Inspection.

3.4 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION

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PANELBOARDS

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PANELBOARDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

C. Project Commissioning shall be provided by the Owner. Contractor shall coordinate their activities with this service.

1.2 SUMMARY

A. Section includes distribution and branch circuit panelboards.

1.3 REFERENCES

A. NEMA PB 1 - Panelboards

B. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

C. NEMA AB 1 - Molded Case Circuit Breakers

D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

E. UL 50 - Enclosures for Electrical Equipment

F. UL 67 - Panelboards

G. UL 98 - Enclosed and Dead-front Switches

H. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures

I. CSA Standard C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards

J. CSA Standard C22.2 No. 5-M91 - Molded Case Circuit Breakers

K. Federal Specification W-P-115C - Type I Class 1

L. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit And Service.

M. NFPA 70 - National Electrical Code (NEC)

N. ASTM - American Society of Testing Materials

1.4 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. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

B. Product Data: Submit catalog data showing specified features of standard products.

1.5 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.

1.6 QUALIFICATIONS

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

1.7 MAINTENANCE MATERIALS

A. Furnish five of each panelboard key. Panelboards keyed alike.

PART 2 PRODUCTS

2.1 DISTRIBUTION PANELBOARDS

A. Manufacturers:
1. Square-D
2. Cutler-Hammer
3. Siemens
4. GE

B. Interior

1. Panelboard shall have continuous main current ratings, as indicated on associated schedules and drawings, not to exceed 1000 amperes for main breaker panelboards and not to exceed 1200 amperes for main lug panelboards.
2. Minimum Short Circuit Rating: As indicated on the schedules and drawings.
3. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be plated copper aluminum. Bussing rated for 600, 800, and 1000 amperes shall be plated copper as standard construction. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
4. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
5. A solidly bonded copper equipment ground bar shall be provided. An additional copper isolated/insulated ground bar shall also be provided when indicated.
6. Split solid neutral shall be plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length. Provide CSA and UL Listed panelboards with 200% rated solid neutral for non-linear load applications when indicated. Panelboards shall be marked for non-linear load applications.
7. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have filler plates covering unused mounting space.
8. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, CSA/UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.
9. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 125A interiors shall be horizontally mounted. Main circuit breakers over 125A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.
10. Interior phase bus shall be pre-drilled to accommodate field installable options. (i.e., Sub-Feed Lugs, Sub-Feed Breakers, Thru-Feed Lugs)
11. Interiors shall accept 125 ampere breakers in group mounted branch construction.
12. Provide additional lugs to accommodate the oversized feeders.

C. Main Circuit Breaker

1. Main circuit breakers shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.

2. Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
3. Circuit breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be CSA and UL Listed for reverse connection without restrictive line or load markings.
4. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
5. Lugs shall be CSA and UL Listed to accept solid or stranded copper conductors. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.
6. The circuit breakers shall be CSA and UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.

D. Branch Circuit Breakers

1. Circuit breakers shall be CSA and UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedules and drawings.
2. Molded case branch circuit breakers shall have bolt-on type bus connectors.
3. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.
4. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI-TRIP® indicator appearing in the clear window of the circuit breaker housing.
5. The exposed faceplates of all branch circuit breakers shall be flush with one another.
6. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16.
7. Breakers shall be CSA and UL Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch.
8. Breaker shall be CSA and UL Listed with the following ratings: (15-125A) Heating, Air Conditioning, and Refrigeration (HACR), (15-30A) High Intensity Discharge (HID), (15-20A) Switch Duty (SWD), (15-50A) Equipment Protection Device (EPD) (480Y/277Vac maximum).

E. Enclosures

1. Type 1 Boxes

a. Boxes shall be hot zinc dipped galvanized steel constructed in accordance with UL 50 requirements. Unpainted galvannealed steel is not acceptable.

b. Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.

c. Box width shall not exceed 20" wide.

2. Type 1 Fronts

a. Front shall meet strength and rigidity requirements per UL 50 standards. Shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

b. Fronts shall be hinged 1-piece with door. Mounting shall be flush or surface as indicated on associated schedules and drawings.

c. Panelboards rated 250 amperes and below shall have MONO-FLAT fronts with concealed door hinges and trim screws. Front shall not be removable with the door locked. Panelboards rated above 250 amperes shall have vented fronts with concealed door hinges. Doors on front shall have rounded corners; edges shall be free of burrs.

d. Front shall have flat latch type lock with catch and spring loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

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.

H. Install spare conduits out of each recessed panelboard to accessible location above ceiling. Minimum spare conduits: 8 empty 1 inch. Identify each as SPARE.

I. Ground and bond panelboard enclosure. Connect equipment ground bars of panels in accordance with NFPA 70.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Inspect and report concealed damage to carrier within their required time period.

B. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

3.3 WARRANTY

A. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of substantial completion.

3.4 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

C. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

D. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

3.5 ADJUSTING

A. 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.

B. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

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ELECTRICAL CABINETS AND ENCLOSURES

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ELECTRICAL CABINETS AND ENCLOSURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section includes hinged cover enclosures, cabinets, terminal blocks, and accessories.

1.3 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's standard data for enclosures, cabinets, and terminal blocks.

B. 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 QUALIFICATIONS

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

1.6 EXTRA MATERIALS

A. Furnish five of each key.

PART 2 PRODUCTS

2.1 HINGED COVER ENCLOSURES

A. Manufacturers:
1. Carlon Electrical Products
2. Hubbell Wiring Devices
3. Reliance Electric
4. Hoffman
5. Square-D
6. Siemens
7. Cutler-Hammer
8. Hammond

B. Construction: NEMA 250, Type 1 steel enclosure.

C. Covers: Continuous hinge, held closed by flush latch operable by screwdriver.

D. Furnish interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.

E. Enclosure Finish: Manufacturer's standard enamel.

2.2 CABINETS

A. Manufacturers:
1. Carlon Electrical Products
2. Hubbell Wiring Devices
3. Reliance Electric
4. Hoffman
5. Square-D
6. Siemens
7. Cutler-Hammer
8. Hammond

B. Boxes: Galvanized steel with removable end walls.

C. Box Size: Per NEC angle and U-pull calculations.

D. Fronts: Steel, surface type with concealed trim clamps, door with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.

E. Knockouts: Provide as required.

F. Furnish metal barriers to form separate compartments wiring of different systems and voltages.

G. Furnish accessory feet for free-standing equipment.

2.3 TERMINAL BLOCKS

A. Manufacturers:
   1. Carlon Electrical Products
   2. Hubbell Wiring Devices
   3. Reliance Electric
   4. Hoffman
   5. Square-D
   6. Siemens
   7. Cutler-Hammer
   8. Hammond
   9. Ilsco
   10. Burndy

B. Terminal Blocks: NEMA ICS 4.

C. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

D. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

E. Furnish ground bus terminal block, with each connector bonded to enclosure.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.

B. Install cabinet fronts plumb.

3.2 CLEANING

A. Clean electrical parts to remove conductive and harmful materials.

B. Remove dirt and debris from enclosure.

C. Clean finishes and touch up damage.

END OF SECTION

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WIRING DEVICES

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WIRING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

C. Project Commissioning shall be provided by the Owner. Contractor shall coordinate their activities with this service.

1.2 SUMMARY

A. Section includes wall switches; wall dimmers; receptacles; multi-outlet assembly; and device plates and decorative box covers.

1.3 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA WD 1 - General Requirements for Wiring Devices.
   2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.4 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.

1.5 QUALIFICATIONS

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

1.6 EXTRA MATERIALS

A. Furnish two of each style, size, and finish wall plate.

PART 2 PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
1. Cooper Wiring Devices.
2. Hubbell, Inc.
3. Leviton Manufacturing Company.

B. Product Description: NEMA WD 1, Extra Heavy-Duty, AC only general-use snap switch.

C. Body and Handle: Toggle.

D. Indicator Light: Lighted handle type switch.

E. Locator Light: Lighted handle type switch; red color handle.

F. Ratings:
1. Voltage: 120-277 volts, AC.
2. Current: 20 amperes.

G. Color: As selected by Architect.

2.2 RECEPTACLES

A. Manufacturers:
1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.

B. Product Description: NEMA WD 1, Extra Heavy-duty general use receptacle.

C. Device Body: Color as selected by Architect.

D. Configuration: NEMA WD 6, type.

E. Convenience Receptacle: Type 5-20R.

F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.3 WALL PLATES

A. Manufacturers:
1. Cooper Wiring Devices.
2. Harvey Hubbell, Inc.
3. Leviton Manufacturing Company.

B. Decorative Cover Plate: Brushed 302 stainless steel.

C. Jumbo Cover Plate: Brushed 302 stainless steel.

D. Weatherproof Cover Plate: Gasketed cast metal plate with hinged and gasketed device cover.

PART 3 EXECUTION

3.1 EXAMINATION

A. This Contractor shall examine all architectural drawings and details before locating outlets. Outlets shall be placed as required to harmonize with moldings, panels, etc. Outlet locations shall not be obtained from scale dimensions on electrical drawings but from measurements on architectural plans and/or details.

B. If an outlet is installed by this Contractor in such a location as to be out of proper relation to beams, walls, or other details of the building, its location shall be corrected by, and at the expense of this Contractor, at the direction of the Design Professional.

C. Verify outlet boxes are installed at proper height.

D. Verify wall openings are neatly cut and completely covered by wall plates.

E. 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 EXISTING WORK

A. Disconnect and remove abandoned wiring devices.

B. Modify installation to maintain access to existing wiring devices to remain active.

C. Clean and repair existing wiring devices to remain or to be reinstalled.

3.4 INSTALLATION

A. Provide for each device indicated, a box suited to the purpose for which the device is to be put and to the location in which it occurs.

B. Do not install device boxes back to back.

C. Coordinate with Design Professional prior to installation for all device mounting heights.

D. Secure electrical devices firmly in place within boxes, setting devices straight and true with box sides and mounting surface.

E. Install face plate straight and true with mounting surface.

1. Gaps between back of plate and mounting surface are not permitted.
2. Set face plate mounting screws with slots in vertical direction.

F. All backboxes recessed in concrete in CMU masonry walls shall sit flush with face of wall. Provide boxes with proper depth and/or extension ring.

G. Wiring devices to be furnished and installed by this Contractor shall consist of the various types of wall switches, receptacles, outlets, and plates as required for the Electrical Work. The extent of the wiring devices shall be shown on the drawings.

H. Local wall switches near doors shall be located on the strike side of doors as finally hung, whether or not so indicated on the Plans. If, because of the construction, it is not practical to mount on the strike side, these locations shall be brought to the Design Professional's attention, and meet his approval before roughing in.

I. Single pole switches shall switch the ungrounded wire of circuits. Neutral wire shall not run through switches provided with a neutral shunt or bridge.

J. Switches shall be mounted with the long dimensions vertical.

K. All receptacles and communication outlets located next to each other shall be mounted 8" apart (horizontally) center to center.

L. All switches located adjacent to each other shall be ganged under single multi-gang cover plate.

M. Install devices plumb and level.

N. Install switches with OFF position down.

O. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

P. Do not share neutral conductor on load side of dimmers.

Q. Install receptacles with grounding pole on bottom.

R. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

S. Install wall plates on flush mounted switches, receptacles, and blank outlets.

T. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

U. Connect wiring devices by wrapping solid conductor around screw terminal.

V. Use jumbo size plates for outlets installed in masonry walls.

W. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Install wall switch 48 inches above finished floor.

B. Install convenience receptacle 18 inches above finished floor.

C. Install convenience receptacle 6 inches above back splash of counter.

D. Install dimmer 48 inches above finished floor.

3.6 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.

3.7 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.8 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

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SECTION 26 28 19

ENCLOSED SWITCHES

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ENCLOSED SWITCHES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section includes fusible and non-fusible switches.

1.3 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.

1.4 SUBMITTALS

A. Product Data: Submit switch ratings and enclosure dimensions.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.6 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. Square-D
2. Cutler-Hammer
3. Siemens
4. GE

B. Product Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position, 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.
3. Industrial Locations: Type 4X

E. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

F. Furnish switches with entirely copper current carrying parts.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
1. Square-D
2. Cutler-Hammer
3. Siemens

B. Product Description: NEMA KS 1, Type HD with externally operable handle interlocked to prevent opening front cover with switch in ON position 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.
3. Industrial Locations: Type 4X

D. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

E. Furnish switches with entirely copper current carrying parts.

F. Provide auxiliary contacts for all switches associated with the Smoke Control System.

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). 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

PART 3 EXECUTION

3.1 INSTALLATION

A. Height: 5 feet to operating handle.

B. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 for product requirements.

C. Install engraved plastic nameplates in accordance with Section 26 05 53.

D. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

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 7.5.

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ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section includes molded-case and insulated-case circuit breakers in individual enclosures.

1.3 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.4 SUBMITTALS

A. Product Data: Submit catalog sheets showing ratings, trip units, time current curves, dimensions, and enclosure details.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and continuous current ratings of enclosed circuit breakers.

1.6 QUALIFICATIONS

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

1.7 EXTRA MATERIALS

A. Furnish five of each size and type of current limiter.

PART 2 PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKER

A. Manufacturers:
   1. Square-D
   2. Cutler-Hammer
   3. Siemens
   4. GE

B. Product Description: Enclosed, molded-case circuit breaker conforming to NEMA AB 1, suitable for use as service entrance equipment where applied.

C. Service Conditions:
   1. Temperature: 104 degrees F.
   2. Altitude: 3300 feet.

D. Field-Adjustable Trip Circuit Breaker: Circuit breakers with frame sizes 250 amperes and larger have mechanism for adjusting long time, short time, continuous current, short time, long time pickup current setting for automatic operation.

E. Field-Changeable Ampere Rating Circuit Breaker: Circuit breakers with frame sizes 250 amperes and larger have changeable trip units.

F. Current Limiting Circuit Breaker: Circuit breaker indicated as current-limiting have automatically-resetting current limiting elements in each pole. Let-through Current and Energy: Less than permitted for same size Class RK-5 fuse.

G. Solid-State Circuit Breaker: Electronic sensing, timing, and tripping circuits for adjustable current settings, instantaneous trip, and adjustable short time trip.

H. Accessories: As indicated on Drawings. Conform to NEMA AB 1.
   1. Shunt Trip Device: 120 volts, AC.
   2. Auxiliary Switch: 120 volts, AC.
   3. Handle Lock: Provisions for padlocking.

I. Enclosure: NEMA AB 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.
   3. Industrial Locations: Type 4X

J. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

PART 3 EXECUTION

3.1 INSTALLATION

A. Height: 5 feet to operating handle.

B. Locate and install engraved plastic nameplates in accordance with Section 26 05 53.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1.

3.2 ADJUSTING

A. Adjust trip settings to coordinate circuit breakers with other overcurrent protective devices in circuit.

B. Adjust trip settings to provide adequate protection from overcurrent and fault currents.

END OF SECTION

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SECTION 26 29 13

ENCLOSED CONTROLLERS

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SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section includes manual and magnetic motor controllers in individual enclosures.

B. Related Sections:
1. Section 26 28 13 - Fuses.

1.3 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.

1.4 SUBMITTALS

A. 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.

B. Test Reports: Indicate field test and inspection procedures and test results.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and ratings of enclosed controllers.

B. Operation and Maintenance Data: Submit Replacement parts list for controllers.

1.6 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. Square-D
2. Cutler-Hammer
3. Siemens
4. GE

B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, and toggle operator.

C. Enclosure: NEMA ICS 6, Type to meet conditions of installation.

2.2 FRACTIONAL-HORSEPOWER MANUAL CONTROLLER

A. Manufacturers:
1. Square-D
2. Cutler-Hammer
3. Siemens
4. GE

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, green pilot light, toggle operator.

C. Enclosure: NEMA ICS 6, Type to meet conditions of installation.

2.3 MOTOR STARTING SWITCH

A. Manufacturers:
1. Square-D
2. Cutler-Hammer
3. Siemens
4. GE

B. Product Description: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with green pilot light and toggle operator.

C. Enclosure: NEMA ICS 6, Type to meet conditions of installation.

2.4 FULL-VOLTAGE NON-REVERSING CONTROLLERS

A. Manufacturers:
1. Square-D
2. Cutler-Hammer
3. Siemens
4. GE

B. Product Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

C. Control Voltage: Coordinate in field with Mechanical/ATC Contractor prior to purchasing.

D. Control coil to be encapsulated type.

E. Control: Hand-Off-Auto with red “On” and green “Off” indicating lights and start/stop buttons.

F. Contacts: Totally enclosed, double-break, silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.

G. Wiring: Straight-through wiring with all terminals clearly marked.

H. Overload Relay: NEMA ICS 1:

1. Solid State: Trip current rating will be established by selection of overload relay and shall be adjustable (3 to 1 current range). The overload shall be self-powered, provide phase loss and phase unbalance protection, have a permanent tamper guard, and be ambient insensitive. It will also be available in Trip Class 10 or 20 and have a mechanical test function.
2. Outputs: Unit will be designed for addition of either a normally open or normally closed auxiliary contact and be field convertible.
3. Reset: Unit shall offer both manual reset and remote reset using an external module.
4. Overload relay size shall be based on motor nameplate and not the starter size.

I. Product Features:

1. Auxiliary Contacts: NEMA ICS 2, 2 each field convertible contacts in addition to seal-in contact.
2. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty type.
3. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
4. Pushbuttons: Shrouded type.
5. Indicating Lights: LED type.

6. Selector Switches: Rotary type.
7. Relays: NEMA ICS 2.
8. Control Power Transformers: Provide in each motor starter. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

J. MOCP Combination Controllers: Combine motor controllers with disconnect in common enclosure, using motor circuit protector conforming to NEMA AB 1, with integral instantaneous magnetic trip in each pole. Obtain IEC Class 2 coordinated component protection.

K. Non-Fused Combination Controllers: Combine motor controllers with disconnect in common enclosure, using non-fusible switch conforming to NEMA KS 1, enclosed knife switch with externally operable handle.

L. Fused 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.

M. 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.

2.5 MOTOR CIRCUIT PROTECTORS (MOCP)

A. Motor Circuit Protector: NEMA AB 1 circuit breakers with integral instantaneous magnetic trip in each pole. Circuit breaker shall have a color coded externally operated handle Operating handle shall give positive visual indication of ON/OFF with red and black color-coding.

PART 3 EXECUTION

3.1 INSTALLATION

A. Height: 5 feet to operating handle.

B. Install fuses for fusible switches. Refer to Section 26 28 13 for product requirements.

C. Select and install overload heater elements in motor controllers to match installed motor characteristics.

D. Install engraved plastic nameplates. Refer to Section 26 05 53 for product requirements and location.

E. 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. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

C. Inspect and test each controller to NEMA ICS 2.

END OF SECTION

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SECTION 26 41 00

FACILITY LIGHTNING PROTECTION

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SECTION 26 41 00

FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section includes air terminals, interconnecting conductors, grounding, and bonding for lightning protection of the sports lighting poles and electronic scoreboard/video displays.

1.3 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.

1.4 SYSTEM DESCRIPTION

A. Description: Conductor system protecting entire pole structure and having UL Master Label.

1.5 SUBMITTALS

A. 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.

B. Product Data: Submit catalog sheets showing dimensions and materials of each component, and include indication of listing in accordance with UL 96.

C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

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

E. Certificate of Compliance: Submit certificate from Underwriter's Laboratories indicating approval of lightning protection systems.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 780.

B. Perform Work in accordance with UL 96A and furnish Master Label.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment with minimum twenty years documented experience and member of Lightning Protection Institute.

B. Installer: Authorized installer of manufacturer with minimum ten years documented experience.

C. Inspection Agency: Underwriter’s Laboratories, Inc. (UL)

1.9 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to commencing work of this section.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 COORDINATION

A. Coordinate Work with roofing and exterior and interior finish installations.

PART 2 PRODUCTS

2.1 COMPONENTS

A. Manufacturers:
1. East Coast Lightning Protection.
2. Harger Inc.
3. Erico Inc.
4. Substitutions: Not Permitted.

B. Product Listing: UL 96.

C. Air Terminals:

1. Material: Aluminum.

2. Configuration: Solid.

3. Use adhesive base for single-ply roof installations.
4. Air Terminal for Chimney: Lead-coated copper.
5. Decorations: None.
6. Grounding Rods: Solid copper clad steel.
7. Ground Plate: Copper.
8. Conductors:
    a. Material: Aluminum.
    b. Configuration: Cable.

D. Connectors and Splicers: Aluminum.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 780 and UL 96A.

B. Connect exterior conductors using mechanical connectors. Connect interior conductors using exothermic welding process. Protect adjacent construction elements and finishes from damage.

3.2 FIELD QUALITY CONTROL

A. Perform inspection and testing in accordance with UL 96A.

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SECTION 26 50 00

LIGHTING

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LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section includes interior luminaires, lamps, ballasts, and accessories.

1.3 SCOPE OF WORK

A. Provide and install a complete system of lighting fixtures installed in place, including lamps, wired and connected and left in a satisfactory operating condition. At time of final approval by the Design Professional all fixtures shall be clean and any burned out lamps or ballasts replaced at no additional charge.

B. Contractor shall furnish and install a complete and fully working lighting system with all necessary components, accessories, lamps, and transformers in accordance with the manufacturer's recommendations to meet the specifications and design intent herein. It is the responsibility of the Contractor to ensure all necessary equipment, specialties, and appurtenances are included regardless of the product specification.

C. Contractor shall be responsible for verifying mounting compatibility and plenum clearance of all lighting fixtures and shall notify the Design Professional of any conflicts with structure, HVAC or plumbing prior to the ordering of the equipment in question. Any conflict will be verified in field with the Design Professional.

D. The work to be done under this project includes providing all equipment materials, labor and services, and performing all operations for a complete and operating system. Any work not specifically covered but necessary to complete this installation shall be provided. All equipment and wiring to be new and provided under this contract unless otherwise noted.

E. The Contractor shall perform all cutting and patching of existing masonry construction required by this work. All backboxes, conduit, and wiring shall be concealed in the existing construction unless otherwise noted.

F. The Contractor shall coordinate the lighting fixture installation with all other trades.

G. Upon completion of work, the Contractor shall clean light fixtures and lenses. Equipment shall be adjusted to direction by Design Professional. All systems shall be tested to satisfaction of Owner.

H. Contractor shall be responsible for final targeting of light fixtures under the observation, and according to the recommendations of the Design Professional. Aiming shall take place after dark at a mutually agreed upon time. All costs associated with this effort shall be included in the base bid. Aiming must take place after the project's amenities have been installed. Amenities shall include but not necessarily be limited to plantings, furniture, artwork, graphics, and signage. Contractor shall include in the base bid, provisions for lifts, scaffolding, ladders, and other materials required to complete these adjustments.

I. For each product and/or system, the Design Professional will review (1) original shop drawing submission and (1) resubmission of the same product and/or system. The Design Professional will charge the Contractor $275.00 per hour for review of subsequent shop drawings and review of submittals for any product and/or system not specified.

J. Any substitutions for the specified products on the lighting fixture schedule may result in an adverse change in the intended performance of the lighting fixture or lighting control.

K. The contract drawings and specifications establish the "Minimum Standard of Quality" each product and/or system must meet to be considered acceptable. Products of other manufacturers will be considered, prior to submission of bid, if the product and/or system meets or exceeds the "Minimum Standard of Quality" established by the Design Professional.

L. Approval of unspecified products and/or systems may be obtained by the Contractor who submits written requests at least seven days before the bids are due. Requests after this date will not be considered. It shall be the responsibility of the Contactor requesting the approval of unspecified products and/or systems to prove equality. This statement of proof shall include a line-by-line, item-by-item description of the specified and proposed product and/or system. The request must clearly describe each item for which the approval is requested, including (3) originals (photocopies will not be accepted) of data sheets, manufacturer's name, product name, product order number, complete specifications, descriptive data, test reports, cost savings (per fixture), and a written guarantee by the Contractor that the submitted products and/or systems comply with the specifications in all respects, and if not, will be replaced at his expense with the specified item. In addition, the Contractor shall provide electronic lighting calculations indicating illuminance levels, all data pertaining to the space model and reflectances, and the IES files for each fixture.

M. The Design Professional will review the complete submission for compliance with the contract documents. If in the opinion of the Design Professional the product and/or system is acceptable as an equal as herein described, an addendum will be issued. The acceptance will not, in any way, relieve the Contractor or his supplier/vendor from full compliance with the contract documents.

1.4 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).

1.5 SUBMITTALS

A. SHOP DRAWINGS: Submit manufacturer's product data on each fixture, lamp, and ballast. See Fixture Schedule Notes for other requirements.

B. Fixture data shall include photometric test data and full catalog number indicating all accessories.

C. Contractor shall submit to the Engineer for review, photographs and specifications that may be required by the Engineer. The submission shall include all fixture types bound in one portfolio.

D. The Contractor, upon award of contract, shall immediately assemble the lighting fixture submittal package and fully coordinate purchase of fixtures with the delivery time for each fixture. The delivery time for each fixture shall be clearly noted on the shop drawings.

E. The Contractor shall include in his construction schedule, the possible rejection of shop drawings and shall be responsible for project delays associated with his failure to submit accurate and complete shop drawings.

F. The Contractor shall pay all fees required by manufacturer and Engineer for the possible expediting of fixture deliveries.

1.6 QUALIFICATIONS

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

1.7 MOCK-UP

A. Provide luminaires in ceiling assembly mock-up.

B. Locate where directed by Design Professional.

C. Incorporate accepted mockup as part of Work.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 MAINTENANCE MATERIALS

A. Furnish five of each plastic lens type.

B. Furnish stock or replacement lamps amounting to 5%, but not less than 12 lamps in each case, of each type and size lamp used in each type fixture. Deliver replacement stock as directed to OWNER'S storage space. Submit in writing to Engineer that the lamps have been delivered to the OWNER.

C. Furnish ten of each ballast type.

1.10 SUBMITTALS

A. Product Data: Required.

B. Samples: Required.

PART 2 PRODUCTS

2.1 LUMINAIRES

A. Manufacturers:

1. As Scheduled.

2. Substitutions: As Scheduled.

B. Product Description: Complete luminaire assemblies, with features, options, and accessories as indicated on Drawings.

C. Minimum Efficacy, Lamps Greater Than 100 Watts: 60 lumens/W, except where otherwise indicated or permitted by applicable code.

D. All fixtures shall comply with the standards of ETL and RLM and shall bear the National Board of Fire Underwriters label. Each fixture shall bear an I.B.E.W. label.

E. Lighting fixtures shall be of type and manufacturer as described in the lighting fixture schedule on the electrical drawings. Finish and color shall be as selected by the Architect.

F. Lighting fixtures listed on fixture schedule are series, type and modular size only. This Contractor shall be responsible to provide the proper accessories for proper installation of the fixture (i.e. plaster frame, canopies, pendant stems, aircraft cable, etc.).

G. Lamps shall be furnished and installed in each fixture.

2.2 EXIT SIGNS

A. Manufacturers:

1. As Scheduled.

B. Product Description: Complete LED luminaire assemblies, with features, options, and accessories as indicated on Drawings.

C. Product Description: Exit sign fixture.

D. Face: Translucent face with red letters on white background.

E. Input Voltage: 120,277 volts.

F. Lamps: 5 W per side, maximum.

2.3 ELECTRONIC BALLAST (PROGRAM START)

A. Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

B. Ballast shall be provided with integral leads color coded per ANSI C82.11.

C. Ballast shall be Programmed Start.

D. Ballast shall provide Independent Lamp Operation (ILO) for Instant Start ballats allowing remaining lamp(s) to maintain full light output when one or more lamps fail.

E. Ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

F. Ballast shall operate from 60 Hz input source of 120V, 277V or 347V as applicable with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

G. Ballast shall be high frequency electronic type and operate lamps at a frequency above 42 kHz to avoid interference with infrared devices and eliminate visible flicker.

H. Ballast shall have a Power Factor greater than 0.98 for primary lamp.

I. Ballast shall have a minimum ballast factor for primary lamp application as follows: 0.75 for Low Watt, 0.85 for Normal Light Output, and 1.20 for High Light.

J. Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

K. Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.

L. Ballast shall have a Class A sound rating.

M. Ballast shall have a minimum starting temperature of -18C (0F) for standard T8 lamps and 16C (60F) for energy-saving T8 lamps.

N. Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

O. Ballast shall not contain any Polychlorinated Biphenyl (PCB).

P. Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

Q. Ballast shall comply with ANSI C62.41 Category A for Transient protection.

R. Ballast shall comply with ANSI C82.11 where applicable.

S. Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

T. Ballast shall carry a five-year warranty from date of commissioning against defects in material or workmanship.

U. Ballast shall be Advance Transformer or equal by Osram Sylvania or Lutron.

2.4 HIGH INTENSITY DISCHARGE (HID) BALLASTS

A. Manufacturers:

1. Philips Electronic North America.
2. Universal.
3. Sylvania.
4. Venture Lighting International Inc.

B. Product Description: ANSI C82.4, metal halide lamp ballast, suitable for lamp specified, with voltage to match luminaire voltage.

2.5 FLUORESCENT LAMPS

A. Manufacturers:

1. General Electric Corp.
2. Philips Electronic North America.
3. Sylvania.

2.6 HID LAMPS

A. Manufacturers:

1. General Electric Corp.
2. Philips Electronic North America.
3. Siemens Corp.
4. Venture Lighting International Inc.
5. Sylvania.

2.7 GENERATOR TRANSFER DEVICE (FIXTURE MOUNTED)

A. Generator-supplied egress lighting shall be provided by using a standard fixture equipped with a Bodine GTD generator transfer device. The device shall be capable of bypassing the wall switch when the auxiliary generator (or central inverter system) powers lighting. The device shall consist of relay switching circuitry and fusing contained in one 8” x 1.18: x 1.18” galvanized steel case; shall operate at 120 or 277 VAC, 60 Hz; shall have all inputs fused to 3A maximum; shall draw 280 mA and 1.6 watts during normal operation; and shall comply with the current NEC. The device shall be UL listed for installation inside, on top of or remote from the fixture and shall be warranted for a full five years from date of purchase.

2.8 GENERATOR TRANSFER DEVICE (REMOTE 20A)

A. Emergency egress lighting shall be provided by using lighting loads equipped with a Bodine GTD20A emergency lighting relay control device. The device shall be capable of bypassing the local switching means when normal utility power has been lost. The device shall consist of relay switching circuitry, a test switch, a normal power indicator light and an alternate power indicator light contained in one 9” x 6” x 3.5” enclosure; shall sense normal power at 120 through 277 VAC, 50/60 Hz; shall be rated for 120 277 VAC, 50/60 Hz at up to 20 amps of lighting load; shall draw 45 mA and 4.0 watts during normal sensing operation; and shall comply with the current NEC. The device shall be UL listed for field installation in indoor or damp locations and shall be warranted for a full five years from date of purchase.

PART 3 EXECUTION

3.1 INSTALLATION

A. All fixtures shall be erected and shall hang perfectly plumb with canopies set squarely against the wall or ceiling. They shall be completely wired with wires of the same grade and insulation as specified for lighting circuit work with all splices using spring type solderless connectors according to NEC rules.

B. CONTRACTOR shall check the type of ceiling where recessed fixtures are installed to be sure the proper type of mounting hardware is ordered and to determine if a lay-in type fixture or otherwise is required or if plaster rings are required. He shall be responsible to see that the proper type fixture is installed to suite the ceiling condition and mounting depth.

C. Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or fingerprinting and shall be, at the time of acceptance by OWNER, completely clean.

D. Fixture housing and door frames shall be fully sealed against light leakage. Light leaks between ceiling trims of recessed lighting equipment and the ceilings will not be permitted. Recessed fixture openings cut into the general construction shall not be larger than the fixtures trim ring. Contractor shall be responsible for all fixture cutting and patching.

E. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at indicated height.

F. Support luminaires independent of ceiling framing.

G. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

H. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

I. Exposed Grid Ceilings: Install auxiliary members spanning ceiling grid members to support surface mounted luminaires.

J. Install recessed luminaires to permit removal from below.

K. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

L. Install clips to secure recessed grid-supported luminaires in place.

M. Install wall-mounted luminaires at height as indicated on Drawings.

N. Install accessories furnished with each luminaire.

O. Connect luminaires to branch circuit using flexible conduit.

P. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

Q. Install specified lamps in each luminaire.

R. Ground and bond interior luminaires.

3.2 FIELD QUALITY CONTROL

A. Replace defective and burnt out lamps for a period of one year following the Date of Substantial Completion.

B. At Date of Substantial Completion, replace lamps in lighting fixtures which are observed to be noticeably dimmed after CONTRACTOR'S use and testing, as judged by OWNER.

C. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING AND CLEANING

A. Clean interior of lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses, louvers, and cones. If fingerprints and smudges cannot be cleaned, the lenses, louvers, and cones shall be replaced with new.

B. Protect installed fixtures from damage during remainder of construction period.

C. Aim and adjust luminaires as indicated on Drawings.

3.4 CLEANING

A. Remove dirt and debris from enclosures.

B. Clean photometric control surfaces as recommended by manufacturer.

C. Clean finishes and touch up damage.

3.5 GROUNDING

A. Provide equipment grounding connections for interior lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounds.

3.6 DEMONSTRATION

A. Upon completion of installation of interior lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units and proceed with retesting.

END OF SECTION

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SECTION 26 56 00

ATHLETIC FIELD SPORTS LIGHTING

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SECTION 26 56 00

ATHLETIC FIELD SPORTS LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section Includes:

1. Sports field lighting.
2. Poles and cross arms.
3. Contactor cabinets.
4. Pole foundations

B. Work covered by this section of the specifications shall conform to the contract documents, engineering plans as well as state and local codes.

C. The purpose of these specifications is to define the performance and design standards for the Athletic Field Sports Lighting Systems. The manufacturer / contractor shall supply lighting equipment to meet or exceed the standards set forth by the criteria set forth in these specifications.

D. The primary goals of this sports lighting project are:

1. Guaranteed Light Levels: Selection of appropriate light levels impact the safety of the players and the enjoyment of spectators. Therefore the lighting system shall be designed such that the light levels are guaranteed for a period of 25 years.
2. Environmental Light Control: It is the primary goal of this project to minimize spill light and glare.
3. Life Cycle Cost: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate.

E. The work to be done under this project includes providing all equipment materials, labor and services, and performing all operations for a complete and operating system. Any work not specifically covered but necessary to complete this installation shall be provided. All equipment and wiring to be new and provided under this contract unless otherwise noted.

F. Provide and install a complete system of sports lighting fixtures and poles installed in place, including lamps, wired and connected and left in a satisfactory operating condition. At time of final approval by the Design Professional all fixtures shall be clean and any burned out lamps or ballasts replaced at no additional charge.

G. Contractor shall furnish and install a complete and fully working sports lighting lighting system with all necessary components, accessories, lamps, ballasts, contactor cabinets, and controls in accordance with the manufacturer's recommendations to meet the specifications and design intent herein. It is the responsibility of the Contractor to ensure all necessary equipment, specialties, and appurtenances are included regardless of the product specification.

1.3 DESIGN CRITERIA

A. Lighting Performance

1. The manufacturer shall supply equipment to meet or exceed the minimum performance criteria as described below.

B. Lighting Levels

1. The performance criteria for the playing field require lighting equipment, which will provide average maintained illumination in foot-candles (fc) and uniformity ratios as specified in the chart below utilizing Metal Halide fixtures as follows:

Area of Lighting	Average Constant Light Levels	Max to Min Uniformity Ratio	Grid Points (Min)	Grid Spacing (Max)	Lamp (W)	LLF
Football						
- Field	50	2.5:1	72	30'	1500	0.72
- Track	30	2.5:1	46	30'	1500	0.72
Baseball						
- Infield	50	2:1	25	30'	1500	0.72
- Outfield	30	2.5:1	109	30'	1500	0.72
Softball						
- Infield	50	2:1	25	20'	1500	0.72
- Outfield	30	2.5:1	77	20'	1500	0.72
Tennis	50	2.5:1	252	10'	1000	0.72
Soccer	50	2:1	77	30'	1500	0.72
Bleachers	5 (Spill)	10:1	-	10'	1000	0.72

2. Bidders shall supply computer generated point-by-point lighting designs based on 1500 and 1000 watt metal halide utilizing lumens per lamp manufacturers published data. Tilt factors as published by lamp manufacturer shall be determined for each luminaire at its particular aiming angle and included in all calculations. Unique product claims that mitigate/eliminate the use of Light Loss Factor will not be considered. Only established methods of calculation as referenced in the Illuminating Engineering Society of North America (IESNA), Publication RP6-01 will be considered. Copies of IES formatted photometric data must be made available for consultant verification of performance claims. Failure to provide photometric data will be cause to disallow bid, no exceptions.

    a. The manufacturer, when performing the point by point lighting design and the environmental / trespass light control analysis, shall include all site lighting and landscape fixtures. IES files for the site lighting will be furnished by the Design Professional.

3. Initial lumen output of the lamp shall be based upon lamp manufacturers' initial lumen value after 100 hours of lamp operation per ANSI standards. A minimum light loss factor of .95 must be used for initial calculations to allow for sufficient Ballast Factor, as referenced by the IESNA.

4. Average maintained illumination shall be determined by using a maximum light loss factor of .72 calculated per the Illuminating Engineering Society's (I.E.S.) RP-6-01 sports lighting practices (LLF = LLD x BF x LDD x LTF).

5. Uniformity:

    a. Maximum / minimum ratio: The maximum to minimum ratio shall not exceed (see above chart) on the playing field.

    b. Mounting Heights: For proper uniformity and design, luminaire-mounting heights shall be as indicated on the drawings measured above the playing surface.

6. Bleacher spill coverage:

    a. The design shall include illumination of the adjacent bleachers. This can be achieved by either spill over from the Fields/Track or dedicated luminaires directed towards seating areas. In no case shall the allocated wattages per pole be increased by more than 5%.

7. The fixture schedules shown on the drawings are preliminary and to be used as a guide in conjunction with these specifications. The basis of design is Hubbell SportsLiter Solutions which establishes pole locations, heights, and maximum wattage per pole. When preparing your bid, alternate manufacturers are to use the same pole locations and heights as shown. Minor adjustments to locations and quantity of luminaires per pole will be coordinated after award of contract.

C. Environmental / Trespass Light Control:

1. To minimize light trespass, horizontal footcandles (fc) and maximum spill light levels shall not exceed the following criteria. These levels shall be tested as initial fc. (per lamp manufacturer standards, initial is after a 100 hour burn in period) and shall be measured 36" above grade at the designated distances from the boundary (side lines, end lines, foul lines and outfield radius) of the playing field **in any direction**.

Maximum spill shall be calculated at every test point by aiming the meter face toward each group of luminaires and recording the highest footcandle level read. Computer analysis should indicate this maximum spill level.

Distance from Boundary		Horizontal Fc.	Maximum Spill Fc.	Spacing of Test Points
150’	Max. fc	0.5	2.8	267
	Avg. fc	0.1	0.5	267

2. Internal faceted louvers and an external visor shall control spill and glare. External visor shall be painted black and attached to the lens ring system. Internal louvers shall not interfere with re-lamping. No portion of the lamp arc tube shall be directly visible beyond 13° above and 35° to either side measured from the center axis line of the luminaire optical opening.

3. To ensure maximum glare control during the design process, the following design rule must be followed. When aimed, the upper limit of the defined beam (field angle) shall not be more than 80^0 above nadir (10^0 or more downward from the horizontal plane of the luminaire). No more than 5% of the quantity of luminaires used in a lighting project should violate this rule.

D. Testing and Measuring Spill Light

1. Ambient light levels must be measured at the designated test points as provided on the manufacturer’s computer analysis and recorded. These ambient levels must be subtracted from each spill light reading after they are recorded to obtain true spill levels for the lighting system being analyzed.

2. Spill light measurements shall be taken at test points described in the above paragraph.

3. Testing equipment for measuring footcandle levels shall be Minolta Model T-1 illuminance meter or equal. Meter must show proof of calibration as required by its manufacturer and display to .01.

4. After all footcandle tests are completed, a final report shall be provided to the owner of the project. This report should indicate footcandle levels taken on the playing field and spill locations (including and deducting ambient light levels at spill locations).

1.4 FIELD INSPECTION

A. Testing and Computer Analysis: All Testing and Computer Analysis shall generate values based upon the grid size and number of target points per LM-5, the IESNA guide for photometric testing of area and sports lighting installations. (see chart above for minimum requirements)

B. The light meter shall be in a horizontal position 36” above the playing surface for field measurements.

C. To evaluate the actual performance of the installation, illumination measurements should be made on the field using the grids and number of tests points as indicated on the lighting designs. These readings should be taken with the owner or their representative present.

D. Final Approval

1. The manufacturer’s representative shall provide a final report from the test results that shall provide the following items.
2. Identification of number and location of the test grid.
3. Actual horizontal foot-candle readings taken at ach test grid.
4. Number of hours of operation.
5. Maximum to minimum ratios.
6. Date and time of test.
7. Description of weather.

1.5 WARRANTY

A. Each manufacturer shall supply a signed warranty covering the entire system for 25 years. Warranty shall guarantee light levels; lamp replacements; system energy consumption; maintenance and control services, spill light control, and structural integrity. Warranty may exclude fuses, storm damage, vandalism, abuse and unauthorized repairs or alterations. Group lamp replacements for constant light systems must occur in accordance with the independent test report provided by the manufacturer; alternate systems must re-lamp every 2100 hours.

1.6 COMPLIANCE TO SPECIFICATIONS

A. Acceptance of manufacturers other than the Basis of Design does not negate the contractor and lighting manufacturer’s responsibility to comply fully with the requirements of these specifications.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 MAINTENANCE MATERIALS

A. Furnish stock or replacement lamps amounting to 10%, but not less than 32 lamps in each case, of each type and size lamp used in each type fixture. Deliver replacement stock as directed to OWNER'S storage space. Submit in writing to Engineer that the lamps have been delivered to the OWNER.

B. Furnish ten of each ballast type.

PART 2 PRODUCTS

2.1 ATHLETIC FIELD LIGHTING SYSTEM

A. Manufacturers:

1. Hubbell Lighting, Inc. (SportsLiter Basis of Design)
2. Musco
3. Lithonia

B. General Description:

1. The lighting system shall meet the performance requirements herein. The system shall be provided by the manufacturer and consist of remote ballast enclosure(s), pre-aimed and pre-wired socket housings on galvanized steel crossarms, optical reflectors and factory wiring harness, and remote contactor cabinets.
2. All components shall be designed and manufactured as a system. All luminaires, wire harnesses, ballast and other enclosures shall be factory assembled, aimed, wired and tested.
3. All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel of 18-8 grade or better, passivated and coated for protection against corrosion and stress corrosion cracking. All wiring shall be enclosed within the crossarms, pole, or electrical components enclosure.
4. All luminaires shall be constructed with a die-cast aluminum housing or external hail shroud to protect the luminaire reflector system.
5. Manufacturer will remote all ballasts and supporting electrical equipment in aluminum enclosures mounted approximately 10’ above grade. The enclosures shall include ballast, capacitor and fusing for each luminaire.
6. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.

C. Ballasts:

1. Each ballast enclosure will be constructed of.080" thick 5052-H32 aluminum for high corrosion resistance and thermal conduction. The enclosure shall be painted with a minimum of 2 mils of polyester powder coating. A two-compartment design shall be included to isolate ballast and capacitor for cooler operation. Enclosure shall include galvanized steel hinges, lockable stainless steel latches, gasketing, and water tight wire entry. Each enclosure shall be labeled with pole location for easy reference and UL listed for 550C ambient operation.
2. Ballast shall be peak-lead autotransformer for use with 480 volt supply. Capacitors shall be 32Uf, as required by the ballast manufacturers. Dimming or reducing lamp lumens through capacitance switching will not be allowed due to the detrimental effect

on lamp stability and other factors as identified in the National Electrical Manufacturers Association publication LSD14-2002.

3. Provide a safety disconnect switch per circuit for each pole structure. Disconnect switch be located in the remote ballast enclosure.

D. Lamps:

1. The lamps shall be 1000 and 1500 watt Metal Halide and shall meet ANSI designation M48 and be manufactured to current industry standards. The lamps used must be commercially available through local electrical distribution. Approved lamp manufacturers are GE, Philips, and OSI/Sylvania. The fixture manufacturer shall submit the names, addresses and telephone numbers of three local lamp suppliers with the submittal package. Double ended or off axis arc tube lamps are not acceptable.

E. Crossarm Assembly:

1. Crossarm Assembly Shall be pre-wired to a UL listed or recognized quick connector. Each crossarm shall be labeled with pole location for easy installation. All wiring shall be completely enclosed within the crossarm assembly. For ease of maintenance, system must be capable of re-lamping from the front or rear of the assembly. The crossarm assembly must be field adjustable +11 degrees after installation to guarantee square to the field and eliminate the need to re-aim each individual fixture in the event of installation variance.

2. A factory manufactured wiring harness shall be provided. Each harness shall have top and bottom quick connect plugs and labeled for connection at each crossarm and ballast enclosure. The harness shall be matched to luminaire quantity, wattage and pole length. For added protection, the harness shall be completely wrapped with convoluted tubing. The tubing shall be polyethylene type and rated at -40^0F minimum and 200^0F maximum.

F. Optical Assembly:

1. The optical assembly shall consist of a one-piece parabolic spun aluminum Anodal® finished reflector. Lamps shall be standard 1500-watt metal halide lamps available from local suppliers. Exclusive and proprietary lamps will not be accepted. Each optic shall be filtered for optimum performance throughout the life of the luminaire. The fixture manufacturer must manufacturer the reflector.

G. Safety:

1. For safety, the system components shall be UL listed and CSA NRTL/C certified. This shall include the socket housing, remote ballast enclosure, crossarm assembly, wiring harness, junction box and optical reflectors. This system shall be approved under UL1598 and CSA 22.2 No. 9.0 or Binational std. UL 1598/CSA 250. C

2.2 POLE REQUIREMENTS

A. Structural Design:

1. Poles should be designed for the combined effects for both wind and dead load. These loading effects shall be used to determine the maximum allowable loading capacities.

2. Manufacturer shall include in the structural analysis and design of the poles and support bases the structural and wind loads associated with the professional sound system speakers mounted to the poles.

B. Pole Shaft

1. Each pole shaft shall be made of a single ply steel sheet. This steel sheet shall be formed into a tubular shape with one or more longitudinal welds; circumferentially welded splices are not permitted. This tubular shape has a cross-section, which is either multi –sided or round. Multi-sided shall not have a bend radius of less than 2" and do not have a cross-section with less than 12 sides. The material used for these sections shall meet the requirements of ASTM A572 or ASTM A595 Grade-A.

2. Poles exceeding 50 feet in length must be designed as two-piece assemblies. These two-piece assemblies are joined together by telescoping the upper section over the lower section and shall be designed to lap a minimum distance of 1.5 times the inside assembly diameter. Each shaft shall have a galvanized coating in accordance with the requirements of ASTM A123 and shall be completely coated inside and out with a single dip. Double dipping shall not be permitted in compliance with USGA (United States Galvanizing Association) recommended practice.

C. Base Plate and Anchor Bolts

1. Base plates shall be integrally welded to the bottom pole section with either a telescopic weld or a full penetration weld with a back up bar. All bolt holes shall be circumferentially slotted to allow for + 2.5 degrees rotation for field adjustment. The material used will conform to either ASTM A36 or ASTM A572.

2. Anchor bolts shall meet the requirements of ASTM F1554, Grade 55. The bolts shall have a minimum threaded length of at least 6 inches and are galvanized for a minimum of 12" on the threaded end to the requirements of ASTM A153. Each bolt shall be supplied with two hex nuts and two flat washers. Each bolt shall have a "hooked" end on the embedded portion to assist in the development of pull-out-strength.

D. Hand Holes

1. Hand holes shall be peripherally reinforced with a lat bar that is integrally welded to the pole shaft. Each pole shall have a 4" x 6.5" reinforced hand hole located 18" above the finished grade. Cover plates shall be included with all hand holes and must be attached to the pole with a back-bar and screw.

E. Welding

1. All welding shall be performed by AWS (American Welding Society certified welders and all welds comply with the most recent addition of the AWS Structural Welding Code.

F. Shipping

1. Pole structures shall be shipped by truck and shall be firmly secured and packed to assure protection to the structures and finish.

G. Erection and Handling

1. Qualified personnel, utilizing equipment that is designed for handling and erection procedures of this nature, shall perform transportation and handling on job site.

H. Pole location tolerance is $\pm$ 5'.

1. The pole, when loaded with the fixture quantity specified, shall be rated for 120 mph winds.

2.3 FOUNDATION

A. The Lighting Manufacturer shall provide foundation design for the specific pole heights. An independent Professional Engineer licensed in the State of Delaware shall produce signed & sealed pole foundation designs. Lighting Manufacturer employees will not be allowed to develop foundation designs to protect the owners' interests in regards to safety.

B. A Geotechnical report shall be provided to the lighting manufacturer, by owner, with the following information:

1. Soil boring to 25-foot depth (unless rock is encountered) at each pole location with the following information;
2. Soil types, USCS groups
3. Standard penetration test
4. Soil density
5. Rock quality designation, if rock
6. Rock classification
7. Sulphate concentration
8. Ground water elevation
9. Plastic limit and plastic index
10. Site map showing grade changes across parcel and any close structures to proposed poles.
11. On soil boring 200' of linear distance is recommended.

C. Typical or Rule-of-Thumb foundations will not be acceptable. An independent Professional Engineer per the soil bore test and pole reaction information must design foundations.

D. The bidding contractor shall obtain the Geotechnical report from Owner prior to submitting bid.

E. Foundation design will be based on 2009 IBC, 120 mph, Exposure C., 1.0 Importance Factor.

F. Structural Design: The stress analysis and safety factor of the poles shall conform to AASHTO 2001 (LTS-4) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

G. Soil Conditions: The design criteria for these specifications are based on soil design parameters as outlined in the geotechnical report. If a geotechnical report is not provided by the owner, the foundation design shall be based on soils that meet or exceed those of a Class 5 material as defined by 2009 IBC, Table 1806.2.

H. It shall be the contractor's responsibility to notify the owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated.

I. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole.

2.4 BASE FOUNDATION DESIGN

A. The base foundation design shall be a poured in place foundation that has been designed by a licensed professional structural engineer, registered in the State of Delaware. The poured in place foundation shall utilize anchor bolts as describe above.

2.5 ALTERNATE BASE DESIGN

A. Pre-stressed concrete base embedded in concrete backfill allowed to cure for 12-24 hours before pole stress is applied. To alleviate concerns of corrosion at or near grade level and to curtail the need for corrosion inspections and maintenance in the same area, direct burial steel poles will not be permissible.

B. The base foundation design shall be designed by a licensed professional structural engineer, registered in the State of Delaware

2.6 CONTROLS

A. Each pole shall be independently controlled through the Lutron central lighting control system. Contractor shall expand the existing Lutron system and provide all lighting network interfaces, relays, control stations, wiring, etc. for a complete functional system that can be remotely controlled by the existing system located in the High School building.

2.7 CONTACTOR CABINETS

A. Contactor cabinet to provide on-off control of the lighting system, constructed of NEMA Type 4 aluminum. Cabinet shall contain custom configured 60A contactor modules, labeled to match field diagrams and electrical design. Manual Off-On-Auto selector switches shall be provided.

B. Control coil voltage shall be 120 volt. Contractor shall provide a control branch circuit from local panelboard, through the Lutron relay panel, to each contactor.

C. Dimensions: 24” wide x 12” deep. A minimum of (8) eight contactors shall be installed in a single cabinet.

2.8 LIGHTNING PROTECTION

A. All structures shall be equipped with lightning protection meeting NFPA 780 standards. Contractor shall supply and install a ground rod of not less than 5/8” in diameter and 8’ in length, with a minimum of 10’ embedment. Ground rod should be connected to the structure by a copper main down conductor with a minimum size of #2 for poles with less than 75’ mounting height and 2/0 for poles with more than 75’ mounting height.

2.9 ELECTRIC POWER REQUIREMENTS

A. Electric power: 480 volt, 3 phase.

B. Maximum total voltage drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA RP-6-01, Appendix B.

B. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles, uniformity ratios, and maximum kilowatt consumptions are not in conformance with the requirements of the performance specifications and submitted information, the Manufacturer shall be liable to any or all of the following:

1. Manufacturer shall at his expense provide and install any necessary additional fixtures to meet the minimum lighting standards. The Manufacturer shall also either replace the existing poles to meet the new wind load (EPA) requirements or verify by certification by a licensed structural engineer that the existing poles will withstand the additional wind load.

2. Manufacturer shall minimize the Owner's additional long term fixture maintenance and energy consumption costs created by the additional fixtures by reimbursing the Owner the amount of $1,000.00 (one thousand dollars) for each additional fixture required.

3. Manufacturer shall remove the entire unacceptable lighting system and install a new lighting system to meet the specifications.

C. The Contractor shall coordinate the lighting fixture installation with all other trades.

D. Upon completion of work, the Contractor shall clean light fixtures and lenses. Equipment shall be adjusted to direction by Design Professional. All systems shall be tested to satisfaction of Owner.

E. Contractor shall be responsible for final targeting of light fixtures under the observation, and according to the recommendations of the Design Professional. Aiming shall take place after dark at a mutually agreed upon time. All costs associated with this effort shall be included in the base bid. Aiming must take place after the project's amenities have been installed. Amenities shall include but not necessarily be limited to plantings, furniture, artwork, graphics, and signage. Contractor shall include in the base bid, provisions for lifts, scaffolding, ladders, and other materials required to complete these adjustments.

END OF SECTION

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FIRE ALARM SYSTEM EXPANSION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and applicable sections of Division 00 – Procurement and Contracting Requirements and Division 01 – General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 REFERENCES

1. NFPA 72 - National Fire Alarm Code.
2. NFPA 92A - Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences 2006 Edition.
3. NFPA 92B - Standard for Smoke Management Systems in Malls, Atria, and Large Spaces 2005 Edition.
4. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
5. NFPA 70 National Electrical Code
6. NFPA 90A Standard For The Installation of Air Conditioning and Ventilating Systems
7. NFPA 101 Life Safety Code
8. FM Global (Factory Mutual (FM)):FM Approval Guide
9. UL Fire Protection Equipment Directory
10. UL Electrical Construction Materials Directory
11. UL 38 – Manually Actuated Signaling Boxes for Use With Fire Protection Signaling Systems
12. UL 228 – Door Holding Devices
13. UL 268 - Smoke Detectors for Fire Protective Signaling Systems
14. UL 268A - Smoke Detectors for Duct Application
15. UL 464 - Audible Signal Appliances
16. UL 497A – Secondary Protectors for Communications Circuits
17. UL 521 - Heat Detectors for Fire Protective Signaling Systems
18. UL 864 - Control Units for Fire Protective Signaling Systems
19. UL 1076 – Security
20. UL 1283 – Electromagnetic Interference Filters
21. UL 1449 - Transient Voltage Surge Suppressors
22. UL 1480 - Speakers for Fire Protective Signaling Systems
23. UL 1971 - Signaling Devices for the Hearing Impaired
24. State and Local Building Codes as adopted and/or amended by The Authority Having Jurisdiction, ADA, and/or State and local equivalency standards as adopted by The Authority Having Jurisdiction.

25. Equipment and labor not specifically referred to herein or on the plans, but which are required by the codes and standards, shall be provided without additional cost to the Owner.

1.3 SCHEDULES

A. Provide a schedule of the work indicating the following:

1. Intended sequence of work items.
2. Start dates of individual work items.
3. Duration of individual work items.
4. Planned delivery dates for major materials and equipment and expected lead times.
5. Milestones indicating possible restraints on work by other trades or situations.
6. Provide weekly written status reports indicating work completed and revisions to expected delivery dates. Include an updated project schedule and number of workers on the project.

1.4 DEFINITIONS

A. ASME: American Society of Mechanical Engineers
B. FACP: Fire alarm control panel.
C. FM: FM Global (Factory Mutual)
D. Furnish: To supply the stated equipment or materials.
E. Install: To set in position and connect or adjust for use.
F. LED: Light-emitting diode.
G. NCC: Network Command Center
H. NFPA: National Fire Protection Association. Definitions in NFPA 72 apply to fire alarm terms used in this Section.
I. NICET: National Institute for Certification in Engineering Technologies.
J. Provide: To furnish and install the stated equipment or materials.
K. UL: Underwriters Laboratories

1.5 SUMMARY

A. This specification describes the expansion of the existing High School Building EST Fire & Safety fire alarm system. The expansion shall cover each remote field house and maintenance building.

B. Provide new fire alarm system panels in the remote buildings with network connection back the existing system. Contractor shall obtain the cable lengths back to the existing system to determine the type of communication. Provide fiber optic communications where cable lengths preclude the use of copper wiring.

C. Provide all required software changes and modifications to the existing system equipment to monitor and control the new fire alarm systems in the remote buildings.

D. Activation of the remote building(s) fire alarm system shall:
1. Sound alarm and activate visible notification in the affected building only.
2. Send supervisory signal to existing High School building fire alarm system.

3. Report alarm to central station either through the remote building panels or from the central system.
4. The control panel shall be intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. The features and capacities described in this specification are required as a minimum for this project and shall be furnished by the successful contractor.

E. The Contractor shall give all necessary notices, obtain all permits, and pay all governmental taxes, fees, deposits, and other costs in connection with his work. He shall file all necessary plans, prepare all documents, and obtain all required Certificates of Inspection and Approval for his work, including those for occupancy.

F. The Contractor shall include in his work, without extra cost to the Owner, any labor, materials, services, apparatus, drawings, in addition to Contract Documents, in order to meet the functional intent and comply with all applicable Codes, Laws, Ordinances, Rules and Regulations, whether or not indicated in the Construction Documents.

G. Fire Alarm System: NFPA 72, manual and automatic local fire alarm system with connections to central station and Owner's remote monitoring system.

H. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether or not specifically itemized herein.

I. All equipment furnished shall be new and the latest state of the art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over ten years.

J. The system as specified shall be supplied, installed, tested and approved by the local Authority Having Jurisdiction, and turned over to the owner in an operational condition.

K. In the interest of job coordination and responsibilities the installing contractor shall contract with a single supplier for fire alarm equipment, engineering, programming, inspection and tests.

L. General Requirements:

1. The control panel shall be intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques and voice evacuation.
2. The system shall be in full compliance with National and Local Codes.
3. Weatherproof audible/visual device on the exterior of the building.
4. Manual fire alarm boxes (pull stations) not more than 5 feet from entrance to each exit. The height of the pull stations shall be a minimum of 42" and a maximum of 48", measured vertically, from the floor level to the activating handle.
5. Provide audible alarms in all areas of the building. The audible alarm notification devices shall provide a sound pressure level of 15 dBA above the average ambient sound level or 5 dBA above the maximum sound level having a duration of at least 60 seconds, whichever is greater, in every space within the building. Minimum sound pressure level

shall be 70 dBA, except for Mechanical Equipment Rooms which shall be minimum 90 dBA.

6. Provide visible alarm notification appliances (strobes) in the following areas:
   a. Public and common areas
   b. Employee work areas
   c. Each Toilet Room
   d. Common corridors
   e. Equipment Rooms
   f. Classrooms and Laboratories
7. Provide two independent telephone lines (dial tone) to the fire alarm system for central station monitoring of alarm, trouble, and supervisory conditions will be provided.
8. Smoke detectors to be provided throughout the building.
9. Duct mounted smoke detectors to be located in all supply and return air ductwork.
10. The system will be networkable.
11. NAC panels will be provided to power the notification devices.
12. Batteries shall be sized for 15 minutes of alarm at full load after 24 hours of system standby.
13. Provide all magnetic door holders.

1.6 SYSTEM DESCRIPTION

A. The system shall be a complete, electrically supervised fire detection and notification system, with a microprocessor based operating system having the following capabilities, features, and capacities:
   1. Support of mobile test system capable of providing point test reports in NFPA standard format without manual report entries.
   2. The control panel shall allow control and monitoring from a wireless handheld display device during maintenance, inspection and troubleshooting tasks.
   3. System shall provide an output port for monitoring purposes by external systems. Communications to an external system shall be RS-232 or RS-485 communications.
   4. Communications between network nodes, each supporting an interactive, self-standing, intelligent local control panel, with system wide display. Any network node shall be capable of supporting a local system in excess of 4000 input/output points.
   5. The local system shall provide status indicators and control switches for all of the following functions:
      a. Audible and visual notification alarm circuit zone control.
   6. Each intelligent addressable device or conventional zone on the system shall be displayed at the Central Alarm Receiving Terminal and the local fire alarm control panel by a unique alphanumeric label identifying its location.

1.7 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with NFPA 72 and all contract documents and specification requirements.

B. System shall be a complete, supervised, noncoded, addressable multiplex fire alarm system conforming to NFPA 72.

C. The system shall have Style 4 circuits.

D. The system shall provide the following functions and operating features:

1. The FACP and auxiliary power panels shall provide power, annunciation, supervision and control for the system.
2. Provide Class B initiating device circuits.
3. Provide Style 7 signaling line circuits for the network.
4. Provide Class B notification appliance circuits. Arrange circuits to allow individual, selective, and all-call visual notification by zone. Notification Appliance circuits shall be zoned to correspond with the building fire barriers and other building features.
5. Strobes shall be synchronized throughout the entire building.
6. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.

E. The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not being tested. Alarms, supervisory signals, trouble signals shall be logged on the system printer and in system history during the walk-test.

F. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

G. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual pull station
2. Heat detector
3. Addressable area smoke detector
4. Duct smoke detector

H. Activation of any system fire, security, supervisory, trouble, or status initiating device shall cause the following actions and indications at all network Person Machine Interfaces using basic graphics and multiple detail screens.

1. Fire Alarm Condition:
    a. Sound an audible alarm and display a custom screen/message defining the building in alarm and the specific alarm point initiating the alarm in a graphic display.
    b. Log into the system history archives all activity pertaining to the alarm condition.
    c. Print alarm condition on system printer.

d. Sound the ANSI 117-1 signal with synchronized audibles and synchronized strobes throughout the facility.

e. Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmable to flash until system reset or alarm silencing, as required.

f. The alarm information shall be displayed on the existing Graphic Annunciator.

g. System operated duct detectors as per local requirements shall accomplish HVAC shut down.

h. Door closure devices shall operate by floor or by local requirements.

2. Supervisory Condition:

a. Display the origin of the supervisory condition report at the local fire alarm control panel graphic LCD display and at the existing remote annuciator.

b. Activate supervisory audible and dedicated visual signal.

c. Audible signals shall be silenced from the control panel by the supervisory acknowledge switch.

d. Record within system history the initiating device and time of occurrence of the event.

3. Trouble Condition

a. Display at the local fire alarm control panel graphic LCD display and at the existing remote annuciator.

b. Activate trouble audible and visual signals at the control panel and as indicated on the drawings.

c. Audible signals shall be silenced from the fire alarm control panel by a trouble acknowledge switch.

d. Trouble conditions that have been restored to normal shall be automatically removed from the trouble display queue and not require operator intervention. This feature shall be software selectable and shall not preclude the logging of trouble events to the historical file.

e. Trouble reports for primary system power failure to the master control shall be automatically delayed for a period of time equal to 25% of the system standby battery capacity to eliminate spurious reports as a result of power fluctuations.

f. Record within system history, the occurrence of the event, the time of occurrence and the device initiating the event.

I. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1.8 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Complete manufacturer's catalog data including supervisory power usage, alarm power usage, physical dimensions, and finish and mounting requirements.

B. Power calculations. Battery capacity calculations. Battery size shall be a minimum of 125% of the calculated requirement. Provide the following supporting information:

1. Supervisory power requirements for all equipment.
2. Alarm power requirements for all equipment.
3. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst-case condition plus 25% spare capacity.
4. Voltage drop calculations for wiring runs demonstrating worst-case condition.
5. NAC circuit design shall incorporate a 15% spare capacity for future expansion.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Complete drawings covering the following shall be submitted by the contractor for the proposed system:
    a. Floor plans in a CAD compatible format at a scale of 1/8”=1’-0” showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used.
    b. Provide a fire alarm system function matrix as referenced by NFPA 72, Figure A-7-5.2.2 (9). Matrix shall illustrate alarm input/out events in association with initiation devices. Matrix summary shall include system supervisory and trouble output functions. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at time of bid.
4. Installation drawings shop drawings, and as-built drawings shall be prepared by an individual experienced with the work specified herein.
5. Incomplete submittals shall be returned without review, unless with prior approval of the Engineer.

D. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Light fixtures.
2. HVAC registers

E. Qualification Data: For qualified Installer, Applicator, manufacturer, fabricator, professional engineer, testing agency, and factory-authorized service representative.

F. Source quality-control reports.

G. Field quality-control reports.

H. Operation and Maintenance Data: For all fire alarm equipment, to include in operation and maintenance manuals.

I. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

J. Warranty: Sample of special warranty.

1.9 QUALIFICATIONS

A. Supplier Qualifications

1. Wayman Fire Protection, Inc.

B. Installer Qualifications:

1. Before commencing work, submit data showing that the manufacturer has successfully installed fire alarm systems of the same scope, type and design as specified.
2. The contractor shall submit copies of all required Licenses and Bonds as required in the State having jurisdiction.
3. The contractor shall employ on staff a minimum of one NICET level IV technician or a professional engineer, registered in the State of the installation.
4. Contractors unable to comply with the provisions of Qualification of Installers shall present proof of engaging the services of a subcontractor qualified to furnish the required services.

C. Testing Agency Qualifications: Qualified for testing indicated.

D. Source Limitations for fire alarm equipment: Obtain fire alarm equipment from single source.

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

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.
3. Combustion Characteristics: ASTM E 136.

F. 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.

G. Preinstallation Conference: Conduct conference at Project site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.

B. Store materials inside, under cover, above ground, and kept dry and protected from physical damage until ready for use. Remove from site and discard wet or damaged materials.

1.11 PROJECT CONDITIONS

A. Installed products or materials shall be free from any damage including, but not limited to, physical insult, dirt and debris, moisture, and mold damage.

B. Environmental Limitations: Do not deliver or install products or materials until spaces are enclosed and weathertight, 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.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire alarm equipment that fail(s) in materials or workmanship within specified warranty period.

B. Warranty Period: 5 years from date of Start-Up and Commissioning.

1.13 SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for 5 years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

C. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.14 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents as follows:

1. Pluggable LED’s for Remote Indicating Panels: Furnish quantity equal to 20 percent of the number of units installed.
2. Speaker/Strobe and Strobe Units: Furnish quantity equal to 5 percent of the number of each units installed.
3. Smoke Sensors and Heat Detectors: Furnish quantity equal to 5 percent of the number of units of each type installed.
4. Sensor Bases: Furnish quantity equal to 2 percent of the number of units of each type installed.
5. Control and Relay Module: Furnish quantity equal to 5 percent of the number of units of each type installed.

1.15 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.

PART 2 PRODUCTS

2.1 FIRE DETECTION AND ALARM

A. Manufacturers:
   1. EST Fire & Security (Existing High School Building System)

2.2 CONTROL PANEL

A. The fire alarm control panel shall be microprocessor based using multiple microprocessors throughout the system providing rapid processing of smoke detector and other initiation device information to control system output functions.

B. There shall be a watchdog circuit, which shall verify the system processors and the software program. Problems with either the processors or the system program the panel shall activate a trouble signal, and reset the panel.

C. The system modules shall communicate with an RS 485 network communications protocol. All module wiring shall be to terminal blocks, which will plug into the system card cage. The control panel shall be capable of expansion via up to 100 SLCs. Maximum system capacity shall be at least 2500 intelligent initiation devices.

D. System response time from alarm to output shall not exceed three (3) seconds.

E. To expedite system troubleshooting, the system cards shall have ground fault detection, and diagnostic LED’s by card.

F. All system cards and modules shall have Flash memory for downloading the latest module firmware.

G. Networking:

   1. Digital communication capabilities supporting Style 7 (Class A) communications using either DC digital or fiber optics technologies or combinations of both as required for the control panel to communicate with at least 50 remote transponders.

   2. Digital communication capabilities supporting Style 7 (Class A) communications using either DC digital or fiber optics technologies or combinations of both as required for the control panel to communicate with at least 59 network nodes.

   3. Capability shall exist within the system to extend the network at any node. The system shall support a maximum of two network extension circuits in series on any system branch, extending the inherent distance limitations for network communications.

4. Communication protocol shall be of the CSMA/CD (carrier sense, multiple access, collision detect) type, eliminating delays incorporated into other protocols. Communication techniques using token passing and requiring sensing of delays and re-generation of the token to re-establish network communications in the event of a fault shall not be acceptable.

H. Software Modifications: 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. Systems that require the use of external programmers or change of EPROMs are not acceptable.

2.3 POWER SUPPLY

A. The system Power Supply/Charger (PSC) shall be a 12-amp supply with battery charger. The power supply shall be filtered and regulated. The power supply shall have a minimum of 1 power limited output rated at 4 amps, and a minimum of 1 output rated at 12 amps. The system power supply can be expanded up to 48 amps. The auxiliary power supply module shall share common batteries with the primary power supply. The system power supply shall have 4 relays, 1 for common alarm, one for common trouble and two programmable relays. The power supply shall be rated for 120/240 VAC 50/60 Hz.

B. The battery charger shall be able to charge the system batteries up to 100 AH batteries. Battery charging shall be microprocessor controlled and programmed with a special software package to select charging rates and battery sizes. Provide thermistor for monitoring battery temperature to control charging rate.

C. The power supply shall have a plug for an AC adapter cable, which allows a technician to plug in a laptop computer for up or down loading program information or test equipment.

D. Transfer from AC to battery power shall be instantaneous when AC voltage drops to a point where it is not sufficient for normal operation.

2.4 SYSTEM ENCLOSURE

A. Provide the enclosure needed to hold all the cards and modules as specified with at least spare capacity for two cards. The enclosure outer door shall be either black or red. Provide the color as to the local AHJ requirements. The outer doors shall be capable of being a left hand open or a right hand open. The inner door shall have a left hand opening. System enclosure doors shall provide where required ventilation for the modules or cards in the enclosure.

B. Provide system enclosure for all amplifiers. Where required by the manufacturer, provide means for venting heat from the enclosure either by having enclosure sides and top vented or the doors vented.

2.5 INITIATING DEVICES

A. Intelligent Initiation Devices – General

1. All initiation devices shall be insensitive to initiating loop polarity. Specifically, the devices shall be insensitive to plus/minus voltage connections on either Style 4 or Style 6 circuits.

B. Smoke Detectors – Addressable

1. The detector shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detector must provide up to 11 different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.
2. The detector shall have a multicolor LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.
3. The multi-criteria smoke detector shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for a minimum of eleven environmental fire profiles unique to the devices installed location.
4. The detector shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.
5. The intelligent smoke detector shall be capable of providing three distinct outputs from the control panel. The outputs shall be from an input of smoke obscuration, a thermal condition or a combination of obscuration and thermal conditions. The detector shall be designed to eliminate calibration errors associated with field cleaning of the chamber.
6. The detector shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.
7. Detector wiring shall not require any special shielded cable. For the detector where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.
8. Where required, there shall be available a programmable remote lamp configurable to remotely duplicate the on-board LED status of another system device with the same software address.
9. Provide adaptor box for all surface mounted detectors including all apartments.

C. Heat Detectors – Addressable

1. Thermal Detectors shall be rated at 135 degrees fixed temperature and 15 degrees per minute rate of rise. Detectors shall be constructed to compensate for the thermal lag inherent in conventional type detectors due to the thermal mass, and alarm at the set point of 135 degrees Fahrenheit. The choice of alarm reporting as a fixed temperature detector or a combination of fixed and rate of rise shall be made in system software and be changeable at any time without the necessity of hardware replacement.
2. The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet and shall be installed according to the requirements of NFPA 72 for open area coverage.

D. Duct Smoke Detectors – Addressable

1. For duct detector applications, the smoke detector shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in duct installation and sampling assembly installation and shall be insensitive to air velocity changes.
2. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. The detector shall be mounted in a duct detector housing listed for that purpose. The duct detector shall support the use of a remote test switch, relay or LED remote indicator. The duct detector shall be supplied with the appropriate sampling tubes to fit the installation.
3. Where duct detectors are exposed to the weather a weatherproof enclosure shall be available. The duct housing cover shall include a test port for functional testing of the detector without cover removal. The duct housing shall include a cover removal switch capable of indicating cover removal status to the fire alarm control panel.
4. The intelligent duct detector shall have a duct housing with an on-board relay. Also where required, there shall be a standalone housing available with its own power supply and test/reset switch that does not require connection to a fire alarm control panel.
5. Provide all control wiring, devices, and relays to shutdown the associated mechanical equipment.
6. Provide remote test switch with LED indicator.
7. Provide 120V branch circuit from normal/emergency source.

E. Detector Bases – Addressable

1. Detector bases shall be low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4" square or octagonal electrical outlet box.
2. Where selective localized control of electrical devices is required for system operation, furnish and install detector base with software programmed addressable relay integral to the base. The relay shall switch electrical loads within relay ratings, as indicated on the drawings. Operation of the addressable control circuit shall be independent of the number of detectors and relays on the circuit or the number in an alarm state. Relay bases shall be rated for resistive or inductive load (120VAC or 30VDC) 3 amps.
3. Where indicated on the drawings, furnish detector base with integral approved audible evacuation alarm signal having an output of 85db @ 10’. The audible signal shall be individually addressable and software programmed for operation.

F. Manual Pull Stations – Addressable

1. Provide addressable manual stations where shown on the drawings, to be flush or surface mounted as required. Manual stations shall contain the intelligence for reporting address, identity, alarm and trouble to the fire alarm control panel. The manual station communications shall allow the station to provide alarm input to the system and alarm output from the system within less than four (4) seconds.

2. The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching red enamel outlet box.
3. Pull station shall be double action.
4. Where required provide pull stations capable of explosion proof installation, capable of weatherproof installation, two stage operation, reset key operation, and metal housings.

G. Addressable Interface Devices

1. Addressable Interface Devices shall be provided to monitor contacts for such items as water-flow, tamper, and PIV switches connected to the fire alarm system. These interface devices shall be able to monitor a single or dual contacts. An address will be provided for each contact. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive.
2. Where needed a Conventional Zone Module shall connect to the Signal Line Circuit, which will allow the use of conventional initiation devices. This module shall have the ability to support up to 15 convention smoke detectors and an unlimited number of contact devices. This module shall also be capable of monitoring Linear Beam detectors and conventional Flame detectors.
3. Fire Alarm Control Module – Provide addressable intelligent control modules to provide independent control of the apartment strobes and like functions. The module shall be microprocessor based and programmed as an independent, remotely located NAC or similar circuit. The module shall communicate through the SLC and be provided with a supervised 24VDC input. Mount in a standard backbox with coverplate.
4. Fire Alarm Monitor Module – Provide addressable device interface (monitor) modules to assign a unique address and supervision of sprinkler system, generator status, fire pump status, NACP trouble, and like functions. Modules shall be microprocessor based with bi-directional communication. Mount in standard backbox with coverplate.
5. Fire Alarm Relay Module – Provide addressable device interface relay modules to control the elevators, door hold-open devices and like devices. Relay shall be addressable and controlled independently by the control panel. Mount in standard backbox with coverplate.
6. Line Isolation Module – Provide line isolation modules for protection of short circuits on intelligent device circuits. When a short circuit is detected, the module shall isolate the affected segment of the circuit, allowing the remaining devices to continue operation. The module shall be self-restoring. Mount in a standard backbox with coverplate.
7. Single Device Damper Monitoring and Control: When connected to the FACP, a single switch input shall be able to monitor all 3 states of a damper – open, closed, and in transit. When connected to a FACP, a single relay shall be able to fully control a damper (through the relay connected to the motor control) while also using its switch input for monitoring all 3 states of the damper.

2.6 NOTIFICATION APPLIANCES

A. Strobes

1. Visual-notification appliances shall meet and be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service
2. Strobe shall be listed for indoor use, and shall meet the requirements of FCC Part 15 Class B
3. Strobe appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range, and shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens
4. All inputs shall be compatible with standard, reverse polarity supervision of circuit wiring by a Fire-Alarm Control Panel (FACP)
5. The strobe shall be of low-current design
6. The strobe intensity shall have field-selectable settings, and shall be rated per UL Standard 1971 for 15/30/75/95cd or 115/177cd for ceiling mount where Multi-Candela appliances are specified unless otherwise noted.
7. The selector switch for selecting the candela shall be tamper resistant
8. The appliance shall be compatible with sync modules and NACP power supplies with built-in sync protocol when synchronization is required
9. The strobes shall not drift out of synchronization at any time during operation
10. If the sync module or Power Supply fails to operate, (i.e. - contacts remain closed), the strobe shall revert to a non-synchronized flash rate
11. The strobes shall be designed for indoor surface of flush mounting
12. All notification appliances shall be backward compatible

B. Low Profile – Horn and Horn Strobes

1. Horn appliances and horn-strobe appliances shall be UL Listed under Standard 1480 for Fire Protective Service, and horns equipped with strobes shall be listed under UL Standard 1971 for Emergency Devices for the Hearing-Impaired
2. All inputs shall employ terminals that accept #12 to #18 AWG wire sizes
3. Strobe portion of the appliance shall produce a flash rate of one (1) flash per second, and shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens
4. Strobe shall be of low-current design
5. Strobe intensity, where Multi-Candela appliances are specified, shall have field-selectable settings, and shall be rated per UL Standard 1971 for:
   a. 15/30/75/110cd (wall mount) -or-
   b. 135/185cd (wall mount)
   c. 15/30/75/95cd (ceiling mount) -or-
   d. 115/177cd (ceiling mount)
6. Selector switch for selecting the candela shall be tamper resistant

7. The strobe portion, when synchronization is required, shall be compatible with sync modules or NACP power supplies with built-in sync protocol
8. The strobes shall not drift out of synchronization at any time during operation
9. Strobes shall revert to a non-synchronized flash-rate, if the sync module or Power Supply should fail to operate (i.e. – contacts remain closed)
10. Horn and horn-strobe appliances shall be designed for indoor surface or flush mounting
11. Grille cover shall mount to standard electrical hardware requiring no additional trim plate or adapter
12. The finish of the Horns and horn-strobes shall be white.
13. All speaker and speaker-strobe appliances shall be listed for Special Applications: Strobes are designed to flash at 1-flash-per-second minimum over their "Regulated Input Voltage Range"
14. Provide weatherproof speakers/strobes as indicated on the drawings.

2.7 DIGITAL COMMUNICATOR

A. The Mulit-Point Digital Alarm Communicator (MDACT) shall be UL864 listed to provide point identification of alarm, supervisory, security and trouble events to a Central or Remove Receiving Station. The MDACT shall support the following:

1. Ademco Contact ID or SIA protocol
2. Ademco Contact ID selection shall provide the ability to transmit events for up to 999 individual points
3. SIA selection shall provide the ability to transmit events for up to 2040 individual points
4. Programming of accounts and phone numbers
5. Dual phone line interface
6. Line fault monitoring.
7. Automatic 24-hour test

2.8 NOTIFICATION APPLIANCE CIRCUIT POWER EXPANSION PANEL

A. An alarm extender panel shall be provided where needed. The power supply shall be a minimum of 6 amps. The power supply shall contain four supervised notification circuits maximum of 3 amps each circuit. The power supply shall contain built-in synchronizing modules for strobes and audibles. There shall be a 3 amp filtered auxiliary power limited output. There shall be a minimum of 8 options as to the operations of the inputs and outputs. Each panel shall be provided with its own power supply, batteries, and charger. Provide quantity of panels required to power all notification appliances regardless of general layout shown on drawings.

PART 3 EXECUTION

3.1 PROTECTION

A. Contractor shall protect all work and material from damage from its work or employees, and shall be liable for all damages thus caused.

B. Contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted. Contractor shall protect any material that is not immediately installed. Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

C. Project plans and specifications, including the Construction Documents for the new fire pump installation, shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

D. Contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

E. Contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the contractor's work, and the plans and the work of others the Contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this Specification made necessary by the failure or neglect of the Contractor to report such discrepancies shall be made by and at the expense of this Contractor.

F. Remove and replace devices and panel components that are wet, moisture damaged, or mold damaged.

3.2 INSTALLATION

A. Install 14 AWG minimum size conductors for fire alarm detection and signal circuit conductors in conduit.

B. Mount end-of-line device in box with last device or separate box adjacent to last device in circuit.

C. Mount outlet box for electric door holder to withstand 80 pounds pulling force.

D. Connect conduit and wire to door release devices, sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control panels, duct smoke detectors and all initiating/notification devices.

E. Automatic Detector Installation: Conform to NFPA 72.

F. Manufacturer's Field Services: Required.

G. Demonstration and Training: Furnish 12 hours of instruction each for four persons, with manufacturer's representative.

H. Perform work in accordance with the requirements of NFPA 70, NFPA 72 and NECA 1-2006, Standard of Good Workmanship in Electrical Contracting.

I. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.

J. Wiring Method: Install cables in conduit.

K. 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.

L. Provide primary power for each panel from local branch circuit panels. Power shall be 120 VAC service, transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all circuits and devices.

M. Control panels shall be identified with minimum 1/2” letters on laminated plastic nameplates.

N. Manufacturers' name plates and UL or CSA labels are to be visible and legible after equipment is installed.

O. Identifiers shall match record documents.

P. Penetration of floor slabs and fire walls/ceilings shall be fire stopped in accordance with all local fire codes.

Q. Relays and other devices to be mounted in auxiliary panels are to be securely fastened to avoid false indications and failures due to shock or vibration.

R. Wiring within panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

S. All devices and appliances shall be mounted to or in an approved electrical box.

T. Any shorts, opens, or grounds found on new or existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.

U. Contractor shall neatly tie-wrap all field-wiring conductors in the gutter spaces of the control panels and secure the wiring away from all circuit boards and control equipment components. Field-wiring circuits shall be neatly and legibly labeled in the control panel. No wiring except home runs from Life Safety System circuits and system power supply circuits shall be permitted in the control panel enclosures. No wiring splices shall be permitted in any control panel enclosure.

V. Equipment shall be attached to walls, ceiling and floor assemblies and shall be mounted firmly in place. Detectors shall not be supported solely by suspended ceilings. Fasteners and supports shall be sized to support the required load.

W. 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.

3.3 BOXES, ENCLOSURES AND WIRING DEVICES

A. Boxes shall be installed plumb and firmly in position.

B. Extension rings with blank covers shall be installed on junction boxes where required.

C. Junction boxes served by concealed conduit shall be flush mounted.

D. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.

E. "Fire alarm system" decal or silk-screened label shall be applied to all junction box covers.

3.4 CONDUCTORS

A. Each conductor shall be identified as shown on the drawings at each with wire markers at terminal points. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.

B. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.

C. Wiring for strobe and audible circuits shall be a minimum 14 AWG, signal line circuits; 18 AWG twisted shielded, speaker circuits; 18 AWG twisted, telephone circuit; 18 AWG twisted shielded.

D. All splices shall be made using solderless connectors. All connectors shall be installed in conformance with the manufacturer recommendations.

E. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

F. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.

G. Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

H. Product Description: Power limited fire-protective signaling cable, copper conductor, 300 volts insulation rated 105 degrees C.

I. Fire alarm circuit conductors have insulation color or code as follows:

1. Power Branch Circuit Conductors: Black, red, white.
2. Initiating Device Circuit: Black, red.
3. Detector Power Supply: Violet, brown.
4. Signal Device Circuit: Blue (positive), white (negative).
5. Door Release: Gray, gray.
6. Municipal Trip Circuit: Orange, orange.
7. Municipal Fire Alarm Loop: Black, white.

3.5 DEVICES

A. Relays and other devices to be mounted in auxiliary panels are to be securely fastened to avoid false indications and failures due to shock or vibration.

B. Wiring within panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

C. All devices and appliances shall be mounted to or in an approved electrical box.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.

C. A consistent color code for fire alarm system conductors throughout the installation.

3.7 FIELD QUALITY CONTROL

A. 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. Testing General:

1. All Alarm Initiating Devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installing technician and date.
2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
3. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.
4. Test reports shall be delivered to the acceptance inspector as completed.
5. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:
    a. Ladders and scaffolds as required to access all installed equipment.
    b. Multi-meter for reading voltage, current and resistance.
    c. Two way radios, and flashlights.
    d. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
    e. Decibel meter.

f. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.

3.8 ACCEPTANCE TESTING

A. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the engineer in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.

B. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input.

C. The installing contractor prior to the ATP shall prepare a complete listing of all device labels for alphanumeric annunciator displays.

D. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the owner and test results recorded for use at the final acceptance test.

E. Preliminary Testing: Conduct preliminary tests to ensure that all devices and circuits are functioning properly. After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that all panel functions were tested and operated properly. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

F. Final Acceptance Test: Notify the owner in writing when the system is ready for final acceptance testing. Submit request for test at least 14 calendar days prior to the test date. A final acceptance test will not be scheduled until meggar test results, the loop resistance test results, and the submittals required in Part 1 are provided to the owner. Test the system in accordance with the procedures outlined in NFPA 72.

1. Verify that the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
2. Test each initiating and indicating device and circuit for proper operation and response. Disconnect the confirmation feature for smoke detectors during tests to minimize the amount of smoke or test gas needed to activate the detector.
3. Test the system for all specified functions in accordance with the contract drawings and specifications and the manufacturer's operating and maintenance manual.
4. Visually inspect all wiring.
5. Verify that all software control and data files have been entered or programmed into the FACP.
6. Verify that Shop Drawings reflecting as-built conditions are accurate.
7. Measure the current in circuits to assure that there is the calculated spare capacity for the circuits.

8. Measure voltage readings for circuits to assure that voltage drop is not excessive.
9. Measure the voltage drop at the most remote appliance on each notification appliance circuit.

G. The acceptance inspector shall use the system record drawings in combination with the documents specified in this specification during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
   1. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
      a. Open, shorted and grounded signal line circuits.
      b. Open, shorted and grounded notification, releasing circuits.
      c. Primary power or battery disconnected.
   2. System notification appliances shall be demonstrated as follows:
      a. All alarm notification appliances actuate as programmed
      b. Audibility and visibility at required levels.
   3. System indications shall be demonstrated as follows:
      a. Correct message display for each alarm input at the control display.
      b. Correct annunciator light for each alarm input at each annunciator and graphic display as shown on the drawings.
      c. Correct history logging for all system activity.
   4. System off-site reporting functions shall be demonstrated as follows:
      a. Correct zone transmitted for each alarm input
      b. Trouble signals received for disconnect
   5. Secondary power capabilities shall be demonstrated as follows:
      a. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
      b. System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
      c. System battery voltages and charging currents shall be checked at the fire alarm control panel.

3.9 CERTIFICATE OF COMPLIANCE

A. Complete and submit to the Engineer a “Certificate of Compliance” in accordance with NFPA 72, most current edition adopted by the Authority Having Jurisdiction.

3.10 DOCUMENTATION

A. System documentation shall be furnished to the owner and shall include but not be limited to the following:

1. System record drawings and wiring details including one set of reproducible drawings, and a CD ROM with copies of the record drawings in DXF format for use in a CAD drafting program.
2. System operation, installation and maintenance manuals.
3. System matrix showing interaction of all input signals with output commands.
4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
5. System program showing system functions, controls and labeling of equipment and devices.

3.11 DEMONSTRATION

A. Instructor: Include in the project the services of an instructor, who shall have received specific training from the manufacturer for the training of other persons regarding the inspection, testing and maintenance of the system provided. The instructor shall train the employees designated by the owner, in the care, adjustment, maintenance, and operation of the fire alarm system.

B. Training sessions shall cover all aspects of system performance, including system architecture, signaling line circuit configurations, sensor and other initiating device types, locations, and addresses, fire alarm control panel function key operation, and other functions as designated by the owner.

C. Required Instruction Time: Provide 16 hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as are selected by the owner. The instruction may be divided into two or more periods at the discretion of the owner. One training session shall be videotaped by the contractor. Videotapes shall be delivered to the owner.

D. Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the FACP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory and trouble. The instructions shall be approved by the owner.

E. Comprehensive system troubleshooting training shall be provided for a single individual designated by the owner. This session shall be separate and distinct from the above described sessions.

F. All training sessions shall be conducted following final system certification and acceptance. Three additional training sessions shall be provided for all security personnel on all shifts six months after final system certification.

G. All training sessions shall be conducted by an authorized fire alarm system distributor representative, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided.

3.12 SERVICES

A. The Contractor shall warrant the entire system against mechanical and electrical defects for a period of two-(5) years. This period shall begin upon completed certification and test of the system or upon first beneficial use of the system, whichever is earlier.

B. The Contractor or manufacturer shall offer for the Owner's consideration at the time of bidding a priced inspection, maintenance, testing and repair contract in full compliance with the requirements of NFPA 72.

C. The Owner shall have the option of renewing at the price quoted in the bid proposal for single or multiple years up to five years.

D. The Contractor performing the contract services shall be qualified and listed to maintain ongoing certification of the completed system to the UL for specific installed system listing.

E. The Installation Contractor shall furnish training as follows for a minimum of four employees of the system user including fire department personnel.

F. Training in the receipt, handling and acknowledgment of alarms.

G. Training in the system operation including manual control of output functions from the system control panel.

H. Training in the testing of the system including logging of detector sensitivity, field test of devices and response to common troubles.

I. System integration functions and operation.

J. The total training requirement shall be a minimum of 8 hours, but shall be sufficient to cover all items specified and also to ensure seamless integration of fire alarm system to other building systems.

END OF SECTION

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SECTION 33 71 19

ELECTRICAL UNDERGROUND DUCTS/HANDHOLES/PULL BOXES

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 - Introductory Information, Bidding Requirements, and Contract Requirements; and Division 01 - General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

1.2 SUMMARY

A. Section Includes:
   1. Plastic conduit and ductbanks.
   2. Precast concrete manholes, pull boxes, and splice boxes.
   3. Underground duct markers.
   4. Manhole pull/splice box accessories.
   5. Handholes.
   6. Transformer vault pad.

B. Related Sections:
   1. Section 02 41 13 – Selective Site Clearing and Demolition.
   2. Section 26 05 00 – Common Work Results for Electrical.
   3. Section 31 20 00 – Earthwork.
   4. Section 31 25 00 – Soil Erosion and Sediment Control.
   5. Section 32 92 00 – Seeding and Mulch.

1.3 REFERENCES

A. 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.

B. Institute of Electrical and Electronics Engineers:
   1. IEEE C2 - National Electrical Safety Code.

C. 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.

D. Underwriters Laboratories Inc.:
   1. UL 651A - Type EB and A Rigid PVC Conduit and HDPE Conduit.

1.4 SYSTEM DESCRIPTION

A. Interconnected system of conduits, manholes, pull/splice boxes, vaults, and handholes to distribute medium-voltage power, low-voltage power, telephone, and data communications.

B. The majority of the underground conduits, manholes, pull/splice boxes, vaults, and handholes are existing and shown as “Light” on the Electrical Site Plans. Contractor shall extend the conduits to their final location (pole fixtures, panels, transformers, switches, receptacles, etc.). Conduits for light fixtures shall be extended from existing handholes. Provide new conduit runs as shown on the drawings. Both the power and control conduits shall be extended to the fixture poles whether or not the control conduit is being used. No existing or new conduit shall be capped below grade unless noted otherwise.

C. Conduit and duct routing and manhole locations are shown in approximate locations unless dimensions are indicated. Coordinate with the Bid Pac ‘C’ contractor for proper placement of underground conduits and to limit excessively long runs.

D. Medium-voltage: Use rigid PVC schedule 40 conduit.

E. Low-voltage: Use rigid PVC schedule 40 conduit.

F. Telephone and data communication: Use rigid PVC schedule 40 conduit.

G. Security systems: Use rigid PVC schedule 40 conduit.

1.5 SUBMITTALS

A. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes and pull/splice boxes, vaults, and handholes.

B. Product Data: Submit for nonmetallic conduit, duct accessories, and manhole, pull/splice box, vaults, and handhole accessories.

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. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of manholes, pull/splice boxes, vaults, and handholes.

B. Submit digital photographs of all work prior back filling. Digital copy of photographs to be submitted to engineer.

1.7 QUALIFICATIONS

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

1.8 COORDINATION

A. Coordinate Work with existing underground utilities and structures.

1.9 QUALITY ASSURANCE

A. Comply with the National Electrical Code (NEC) and IEEE C2 – National Electrical Safety Code (NESC) for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

1.10 RECEIVING, STORING, AND PROTECTING

A. Receive, store, and protect, and handle products according to NECA 1 – Standard Practices for Good Workmanship in Electrical Construction.

PART 2 PRODUCTS

2.1 PLASTIC CONDUIT

A. Manufacturers:
1. Allied Tube and Conduit
2. Carlon
3. Calconduit Products
4. CANTEX

B. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, with fittings and conduit bodies to NEMA TC 3.

2.2 DUCT SPACERS

A. Furnish duct spacers that provide 3-inch separations between conduits.

B. Manufacturers: Underground Devices "Wunpeece".

2.3 CONCRETE

A. Use concrete with maximum 1/2 inch coarse aggregate and Type 1 Portland cement (ASTM C 150 – Standard Specification for Portland Cement) that has a slump of 6 to 7 inches and acquires a compressive strength of 5000 psi in 28 days.

2.4 RACEWAY MEASURING/PULLING TAPE

A. Furnish raceway measuring/pulling tape with permanently printed measurements in one-foot increments and minimum 1200 lb average breaking strength.

B. Manufacturer: Greenlee “39243” or equal.

2.5 DUCT PLUGS

A. Provide rubber duct plugs that will produce a positive seal in unused ducts against water and gas. Plugs shall be made of soft, expansible rubber compressed with galvanized steel plates and bolts.

B. Provide plugs at each end of each conduit.

C. Manufacturer: Condux, Jackmoon USA, Inc.

2.6 UNDERGROUND DUCT MARKERS

A. Manufacturers:
1. Brimar Pipemarker
2. Seton
3. Electromark,
4. Utility Safeguard, LLC

B. Underground Warning Tape:
1. Power: 3 inch wide minimum plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.
2. Communication: 3 inch wide minimum plastic tape, detectable type, colored orange with suitable warning legend describing buried communication lines.

2.7 HANDHOLES

A. Manufacturers:
1. Quazite or equal.

B. Description: Molded composite handholes and splice/pull boxes comprising modular, interlocking sections complete with accessories.

C. Enclosures, boxes and covers are required to conform to all test provisions of the most current ANSI/SCTE 77 “Specification for Underground Enclosure Integrity” for Tier 22 applications. When multiple “Tiers” are specified the boxes must physically accommodate and structurally support compatible covers while possessing the highest Tier rating. All covers are required to have the Tier level rating embossed on the surface. In no assembly can the cover design load exceed the design load of the box. All components in an assembly (box and cover) are manufactured using matched surface tooling. Independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met are required with each submittal.

D. Shape: Square, rectangular, as indicated on drawings.

E. Nominal Inside Dimensions: As indicated on drawings.

F. Inside Depth: As indicated on drawings.

G. Wall Thickness: As indicated on drawings.

H. Covers: Molded composite with stainless steel tamperproof fasteners. Furnish cover marked ELECTRIC and TELECOMMUNICATION to indicate utility.

I. Duct Entry Provisions: Single duct knockouts, window knockouts.

J. Duct Entry Locations: At each end and each side, as indicated on drawings or as required for conduit routing.

K. Duct Entry Size: To match conduit size.

L. All handholes and splice/pull boxes to have solid bottoms and gasketing.

2.8 MANHOLE AND SPLICE/PULL BOX LID AND FRAME

A. Material shall conform to ASTM A48 – Standard Specification for Gray Iron Castings, Class 35B.

B. Frame and lid shall be suitable for AASHTO HS-20 wheel loads.

C. Minimum clear opening through the frame will be 30 inches.

D. Furnish cover marked ELECTRIC.

E. Provide (1) frame and lid for each power manhole and splice/pull box.

F. Manufacturer: Neenah Foundry Company, Model R-1640-C1 or equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify routing and termination locations of conduits prior to excavation for rough-in.

B. Verify locations of manholes, splice/pull boxes, vaults, and handholes prior to excavating for installation.

C. Install underground conduit systems according to the NEC, the NESC, NECA/NEMA 600 – Standard Practices for installing Underground Nonmetallic Utility Duct, and the requirements in this Section.

D. Conduit system routing shown on Drawings is in approximate locations unless dimensioned. Route as required to complete the system.
   1. Coordinate underground conduit system work to avoid interference with other trades, existing utilities, new/future utilities, and new buildings and structures.
   2. Verify routing and termination locations of conduits before excavation for rough-in.
   3. Verify that field measurements are as shown on Drawings.

E. Position trench so conduits will have the following minimum horizontal and vertical separations from parallel or perpendicular runs other utility pipes or conduits.

UTILITY TYPE	PARALLEL LINES	PERPENDICULAR CROSSINGS
Water	36" horizontal separation	24"
Gravity Sewer	36" horizontal separation	24"
Force Main Sewer	36" horizontal separation	24"
Storm Drain	36" horizontal separation	24"
Natural Gas	60" horizontal separation	24"
Steam or Hot Water	60" horizontal separation	24"
Open Communications	24" horizontal separation of tamped soil or 3" of concrete	12" vertical separation of tamped soil or 3" of concrete
Electrical	12" horizontal separation of tamped soil or 3" of concrete	12" vertical separation of tamped soil or 3" of concrete

3.2 EXCAVATION AND BACKFILL

A. Make excavation for manholes, splice/pull boxes, vaults, and handholes to depth required and to provide solid bearing.

B. Grade trenches for underground conduits to a minimum of 4 inches per 100 ft. toward precast splice/pull boxes and manholes.

C. Keep excavation dry during installation of work.

D. Make trenches of sufficient width to receive work to be installed.

E. Backfill excavations for manholes, splice/pull boxes, vaults, and handholes in 6 inch layers; use soil excavated; remove roots, rocks and sharp objects. Provide coarse sand as required for additional backfill material.

F. Moisture condition backfill soil and compact in accordance with ASTM D 1557 to 95% of maximum density under paved areas and 90% of maximum density under unpaved areas.

G. Overfill excavations to allow for settlement.

3.3 INSTALLATION

A. Installation shall include delivery, unloading, setting in place, coring through walls or other structures where required. Installation shall be performed in accordance with applicable standards, codes, requirements and recommendations of National, State and Local authorities having jurisdiction, the N.E.C. and OSHA.

B. All equipment, etc., shall be firmly installed, plumb and square.

C. All conduits should be left clean, dry and free of debris or other obstructions.

D. At completion of manhole, splice/pull box, vault, handhole, and conduit installation, the interiors shall be left dry and clean of dirt, mortar, concrete, and other debris.

E. The top of installed manholes, splice/pull boxes and vaults shall be flush with the finished grade in the area. A minimum installation of a 6” collar with lid is required. Provide 6” and 12” grade ring riser castings as required to elevate cover flush with finished grade.

F. The manhole, and splice/pull box cover/lid shall be bolted/anchored to the top of the installed grade ring with ½” galvanized hardware.

G. All conduit entry into manholes, splice/pull boxes, vaults, and handholes shall be accomplished by way of core-boring holes thru the walls to enable a tight and proper seal around all conduits.

H. Make changes in direction of conduit runs using long sweep bends.

I. Support conduits with duct spacers.

J. Anchor conduits to bottom of trench using reinforcing steel and wire at intervals not exceeding 10 ft.

K. Test each conduit for blockage or deformation after backfilling.
   1. Use a flexible mandrel/scraper not less than 12 in. long with a diameter approximately 1/4 in. less than the inside diameter of the duct.
   2. Pull a mandrel behind a brush with stiff bristles.
   3. Replace any duct section found blocked or deformed.
   4. Place underground warning tape in backfill 12 inches below the surface.
   5. Install measuring and pulling tape in each duct. Leave not less than 48 inches of slack at each end of the tape. Secure each end of tape.

L. Install conduit with minimum slope of 4 inches per 100 feet (0.33 percent). Slope conduit toward precast manholes, vaults, and splice/pull boxes and away from building entrances.

M. Cut conduit square using saw or pipe cutter; de-burr cut ends.

N. Insert conduit to shoulder of fittings; fasten securely.

O. Join nonmetallic conduit using adhesive as recommended by manufacturer.

P. Wipe nonmetallic conduit 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.

Q. Install no more than equivalent of two 90-degree bends between pull points.

R. Install fittings to accommodate expansion and deflection.

S. Terminate conduit at precast manhole, vault, and splice/pull box entries using end bell.
   1. For conduits installed through holes cut by the contractor, pack opening with non-shrink grout. Feather the edge of the grout around each bell and conform to the curvature of the bell end. Remove sharp edges and projections and fill voids within 6 inches of bell ends.

T. Stagger conduit joints vertically in horizontal runs.

U. Securely anchor conduit to prevent movement during backfilling.

V. Provide suitable pull string in each empty conduit except sleeves and nipples.

W. Swab conduit. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

X. Backfill trenches in accordance with Section 31 20 00.

3.4 INSTALLATION – 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 23.

E. HANDHOLES INSTALLED IN GRASS LANDSCAPE AREAS- The top of installed hand-holes (concrete envelope) shall be flush with the existing grade in the area. The grading from the edge of the concrete envelope shall be accomplished by fanning topsoil away from the concrete envelope at a 2" drop in grade over a 10 ft. radius of the lid itself.

F. HANDHOLES INSTALLED IN CONCRETE SIDEWALKS AND PAVED/ROADWAY AREAS- The top of installed hand-holes (concrete envelope) shall be flush with the existing grade in the area.

G. All Quazite hand-holes shall be installed per Quazite Field Applications Instruction Sheet, which defines an approximate 10" wide X 12" deep sloped concrete ring to be installed around the entire perimeter of the hand-hole itself, for additional support in the event of heavy loading from motor vehicles, tractors, mowers, and other similar equipment.

H. All hand-holes shall be installed as per all standard Strongwell Corp. Quazite Product Field Applications sheets.

I. All conduit entry into hand-holes shall be accomplished utilizing a Greenlee Hydraulic Knockout Punch Driver of appropriate size, or a Greenlee carbide-Grit hole-saw as per Quazite Field Applications Instruction Sheets for hand-holes. All conduits shall be terminated at hand-hole with Carlon box adapters on the interior and glued to a PVC bell end of the conduit on the exterior.

3.5 GROUNDING

A. Install 5/8" diameter x 8 feet copper clad steel ground rod in each manhole, vault, and splice/pull box prior to setting top. Provide ground ring as shown in the Drawings.

END OF SECTION

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SECTION 33 71 73

ELECTRICAL UTILITY SERVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND SECTIONS

A. Drawings and applicable sections of Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements shall govern the work of this contract unless otherwise specified herein and all requirements shall be completely fulfilled to the satisfaction of the Engineer and Owner.

B. All specification sections of Division 07 – Thermal and Moisture Protection, Division 21 – Fire Suppression, Division 22 – Plumbing, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), Division 25 – Direct Digital Control Systems for HVAC, Division 26 – Electrical, and drawings are made part of this contract and shall apply to all work described in this Section.

1.2 SUMMARY

A. Section includes arrangement with Utility Company for permanent electric service; payment of Utility Company charges for service; service provisions; and utility metering equipment.

B. All work shall be in accordance with the City of Dover Electric Department's Electrical Service Handbook.

C. All conduit shall be inspected by the City of Dover Engineering Department prior to backfilling.

D. The Contractor shall include in his bid and pay the City of Dover Extension Fee prior to starting work for the City's portion of the work.

Generally, the City of Dover scope of work is as follows:

- Furnish and Install metering cabinet.

E. The Extension Fee shall be submitted to:
City of Dover
Public Utilities Department
860 Buttner Place
Dover, DE 19984

F. Coordinate and schedule service work with City of Dover Electric Department.
City of Dover
Municipal Electric Department
Gary Lawson, Engineering Fieldman
302.242.8459

G. Electrical power for lighting and operation of construction power tools by all trades shall be provided by Contractor from local utility or Contractor's on site generator. Contractor shall

provide all safety devices, extension cords, and remote outlets as required by regulations and use. All outlets shall be GFCI type.

H. Temporary lighting and wiring shall be provided by the Contractor in accordance with OSHA regulations.

I. The temporary power shall have the capacity to run construction equipment such as welders and floor finishing equipment.

J. Contractor shall pay all utility fees for the temporary service.

K. The temporary electric service shall be metered.

1.3 REFERENCES

TBD

1.4 SYSTEM DESCRIPTION

A. Utility Company: City of Dover.

B. System Characteristics: 12,470 volts, three phase, 60 Hertz.

C. Underground Service Provisions: Underground service entrance to building service entrance equipment.
1. Utility Raceway Connection: At Utility Company's pad-mounted metering cabinet.
2. Utility Service-Entrance Conductor Connection: At Utility Company's pad-mounted metering cabinet.

1.5 SUBMITTALS

A. Submit Utility-Company-prepared drawings.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with Utility Company written requirements.

B. Maintain one copy of each document on site.

1.7 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on Drawings.

1.8 COORDINATION

A. Coordinate with utility company, relocation of overhead or underground lines interfering with construction. Where power lines are to be relocated, bill utility costs, directly to Owner.

B. Contact utility company regarding charges related to service installation. Include utility charges in this contract.

C. Utility charges for service installation will be paid by the Contractor.

PART 2 PRODUCTS

2.1 UTILITY METERS

A. Furnished by Utility Company.

2.2 UTILITY METER BASE

A. Furnished by Utility Company and installed by the Contractor.

2.3 METERING TRANSFORMER CABINET

A. Furnished by Utility Company.

2.4 METERING CABINET PAD

A. Furnished and installed by the Contractor.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify service equipment is ready to be connected and energized.

3.2 INSTALLATION

A. Install service entrance conduits to building service entrance pad mount transformer.

END OF SECTION