

ELECTRICAL GENERAL NOTES:

- A. EACH CONTRACTOR, PROPOSER, SUPPLIER AND/OR MANUFACTURER SHALL REFER TO ALL DOCUMENTS PERTAINING TO THIS PROJECT AND COORDINATE ACCORDINGLY SO AS TO ENSURE ADEQUACY OF FIT, COMPLIANCE WITH SPECIFICATIONS, PROPER VOLTAGE AND CURRENT CAPACITY TO AVOID CONFLICT WITH ANY OTHER BUILDING SYSTEMS. VERIFY ALL SHOP DRAWINGS.
- B. ADDITIONAL ELECTRICAL REQUIREMENTS MAY BE SHOWN ON PLANS FROM OTHER DISCIPLINES IN THIS SET. IT IS THE CONTRACTOR'S RESPONSIBILITY TO REVIEW ALL PLANS AND SPECIFICATIONS FOR A COMPLETE UNDERSTANDING OF THE PROJECT REQUIREMENTS.
- C. WORK SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF ALL LOCAL, STATE AND NATIONAL CODES, INCLUDING BUT NOT LIMITED TO NFPA 70 (NEC), NFPA 72, INTERNATIONAL BUILDING CODES, ETC.
- D. CONTRACTOR SHALL FOLLOW SEISMIC RESTRAINT REQUIREMENTS CONTAINED IN LATEST ADOPTED STATE AND INTERNATIONAL BUILDING CODES, WITH ALL AMENDMENTS AS ADOPTED BY THE CURRENT LEGISLATION. REFER TO ELECTRICAL AND STRUCTURAL SPECIFICATIONS FOR ADDITIONAL INFORMATION.
- E. ALL OFFSETS, TURNS, FITTINGS, TRIM, DETAIL, ETC. MAY NOT BE INDICATED, BUT SHALL BE PROVIDED AS REQUIRED. ADDITIONAL ALLOWANCES SHALL BE INCLUDED FOR SAME AT EACH PROPOSER'S DISCRETION.
- F. INSTALL NO PIPING, CONDUIT, DUCTWORK, ETC. IN A LOCATION OR IN A MANNER WHICH WILL ALLOW FREEZING OR THE COLLECTION OF CONDENSATION THEREON. IF IN DOUBT, CONTACT THE ENGINEER.
- G. ADVISE THE ENGINEER OF ANY CONFLICTS, ERRORS, OMISSIONS, ETC. AT LEAST TEN DAYS PRIOR TO BID DATE, TO ALLOW CLARIFICATION BY WRITTEN ADDENDUM.
- H. WHERE CONFLICTS ARE FOUND BETWEEN DRAWINGS, DETAILS, OR SPECIFICATIONS, THE MORE STRINGENT REQUIREMENT SHALL APPLY. NOTIFY ARCHITECT OF DISCREPANCY IN WRITING.
- I. DEVIATION FROM SPECIFICATIONS OR PLANS REQUIRES PRIOR WRITTEN APPROVAL FROM THE ENGINEERS AND MUST BE SUBMITTED IN WRITING NO LATER THAN TEN DAYS PRIOR TO THE BID DATE.
- J. OBSERVE ALL APPLICABLE CODES, RULES AND REGULATIONS THAT MAY APPLY TO THE WORK UNDER THIS CONTRACT. (CITY, COUNTY, LOCAL, STATE, FEDERAL, MUNICIPALITY, UTILITY COMPANY, OSHA, ETC.).
- K. MOUNTING HEIGHTS FOR WALL MOUNTED DEVICES INDICATED ABOVE FINISHED FLOOR ARE TO CENTER OF DEVICE UNO. MOUNTING HEIGHTS TO CEILING SUSPENDED DEVICES ARE TO BOTTOM OF DEVICE UNO.
- L. INSTALL EQUIPMENT, MATERIALS, ETC. IN STRICT ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS AND DIRECTIONS. IF IN CONFLICT WITH THE DESIGN INDICATED IN CONTRACT DOCUMENTS, ADVISE THE ENGINEER PRIOR TO INSTALLATION FOR CLARIFICATION.
- M. THE PURPOSE AND INTENT OF ALL OF THE DOCUMENTS PERTAINING TO THIS PROJECT IS TO PROVIDE A COMPLETE, FUNCTIONAL, SAFE, LIKE-NEW FACILITY. ANYTHING LESS SHALL BE UNACCEPTABLE.
- N. ALL SYSTEMS, EQUIPMENT AND MATERIALS TO BE INSTALLED IN A NEAT AND WORKMANLIKE MANNER. WORK NOT MEETING THIS CRITERION SHALL BE REMOVED AND REINSTALLED SATISFACTORILY. FINAL DETERMINATION OF THE ACCEPTABILITY OF THE QUALITY OF WORK RESIDES WITH THE ENGINEER.
- O. ALL WORK, MATERIALS, ETC. SHALL BE FULLY GUARANTEED FOR ONE FULL CALENDAR YEAR FROM THE DATE OF SUBSTANTIAL COMPLETION AS DOCUMENTED BY THE ENGINEER, UNLESS LONGER WARRANTY PERIODS FOR EQUIPMENT ARE SPECIFIED, UNLESS OTHERWISE SPECIFIED OR INDICATED. ALL EQUIPMENT AND/OR MATERIALS WITHIN OCCUPIED SPACES OR EXPOSED TO VIEW ON THE BUILDING EXTERIOR SHALL BE FINISHED SO AS TO COMPLEMENT ADJACENT SURFACE, UNLESS OTHERWISE NOTED. COORDINATE WORK AND COLORS WITH ARCHITECT.
- Q. WHERE PENETRATING ROOFING MEMBRANE OR OTHER MATERIALS USED FOR WEATHERPROOFING THE BUILDING, MAKE SUCH PENETRATION IN A WAY THAT DOES NOT DIMINISH THE ROOFING WARRANTY OR INTEGRITY IN ANYWAY. COORDINATE ALL SUCH PENETRATIONS WITH THE ROOFING MANUFACTURER AND ARCHITECT.
- R. ANY VIBRATING, OSCILLATING OR OTHER NOISE OR MOTION PRODUCING EQUIPMENT SHALL BE ISOLATED FROM SURROUNDING SYSTEMS (IN AN APPROVED MANNER). NOISY OR STRUCTURALLY DAMAGING INSTALLATIONS SHALL BE SATISFACTORILY REPLACED OR REPAIRED AT THE INSTALLING CONTRACTOR'S EXPENSE. THE FINAL DECISION ON THE SUITABILITY OF A PARTICULAR INSTALLATION'S ACCEPTABILITY SHALL BE THAT OF THE ENGINEER.
- S. CHECK ALL THREE PHASES WITH A PHASE ROTATION METER. PRIOR TO PLACING IN SERVICE.
- T. PROVIDE DETAILED SHOP DRAWINGS TO ENGINEER PRIOR TO PURCHASING OR INSTALLING ANY EQUIPMENT.
- U. DEVIATIONS IN SIZES, CAPACITIES, FIT, FINISH, ETC. FOR EQUIPMENT FROM THAT PRIME SPECIFIED SHALL BE THE RESPONSIBILITY OF THE PURCHASER OR THAT EQUIPMENT AS POSSIBLE FROM TERMINAL POINT TO TERMINAL POINT. THE WORK OF ALL TRADES, CONTRACTORS OR NOT, SHALL BE THE RESPONSIBILITY OF THE PURCHASER.
- V. THE CONSTRUCTION MANAGER, GENERAL CONTRACTOR, OR WHOMEVER HOLDS THE PRIME CONTRACT(S) FOR THIS CONSTRUCTION IS RESPONSIBLE FOR THE COORDINATION, SCHEDULING AND TIMELINESS OF THE WORK OF ALL TRADES, CONTRACTORS, SUPPLIERS, INSTALLERS, ETC. POOR OR UNTIMELY WORK ON THE PART OF ANY SUBCONTRACTOR SHALL BE RESOLVED BY THE PARTY WHO ENGAGED THEM ON THIS PROJECT.
- W. WHERE MOUNTING HEIGHTS ARE NOT INDICATED OR ARE IN CONFLICT WITH ANY OTHER BUILDING SYSTEM, CONTACT THE ENGINEER BEFORE AFFECTING INSTALLATION. REFER ALSO TO ARCHITECTURAL INTERIOR AND EXTERIOR ELEVATIONS, CEILING HEIGHTS AND OTHER DETAILS OF THESE DOCUMENTS, AS APPLICABLE.
- X. WHERE FIRE-RATED CEILING ASSEMBLIES ARE NOTED, PROVIDE UL-LISTED FIRE-RATED GYPSUM BOARD OR PRE-FABRICATED ENCLOSURES ABOVE LUMINAIRES, CEILING DEVICES, ETC. IN OR ON CEILING, AS REQUIRED TO MAINTAIN CEILING RATINGS.
- Y. COORDINATE THE LOCATION OF DRAINS, ELECTRICAL, OUTLETS, GAS OUTLETS, ETC. WITH ALL CASEWORK, KITCHEN EQUIPMENT, MECHANICAL ROOM EQUIPMENT, ETC. PRIOR TO COMMENCING INSTALLATION. WORK NOT SO COORDINATED SHALL BE REMOVED AND PROPERLY INSTALLED AT THE EXPENSE OF THE RESPONSIBLE CONTRACTOR(S).
- Z. ALL ELECTRICAL COMPONENTS OR EQUIPMENT SHALL BE LISTED AND LABELED BY UNDERWRITERS LABORATORIES OR OTHER APPROVED LISTING AGENCY. APPROVAL AND LABELING OF INDIVIDUAL COMPONENTS ON AN ASSEMBLY IS NOT ACCEPTABLE AS MEETING THIS REQUIREMENT, UNLESS WAIVED BY THE ENGINEER IN WRITING.
- AA. ALL WIRING SYSTEMS SHALL BE INSTALLED WITH A MINIMUM OF SPLICES, CONDUCTORS, WHETHER SINGLE OR MULTI-PAIR, SHALL BE INSTALLED CONTINUOUS INsofar AS POSSIBLE FROM TERMINAL POINT TO TERMINAL POINT.
- BB. NO CONDUIT, SUPPORTS, ETC. SHALL BE RUN THROUGH ACCESS CLEARANCES OF EQUIPMENT BY OTHER TRADES (I.E. VAV BOXES). COORDINATE WITH ALL TRADES PRIOR TO CONSTRUCTION.
- CC. ALL CONTRACTORS SHALL EXERCISE EXTREME CARE IN THE COURSE OF THEIR WORK SO AS TO ENSURE THAT THEY DO NOT INTERRUPT ANY EXISTING SERVICE OR SUB-SERVICE FOR SAFETY PURPOSES. PAY PARTICULAR ATTENTION TO THIS PRECAUTION RELATIVE TO NATURAL GAS AND ELECTRICAL LINES. VERIFY THE LOCATION, SIZE, TYPE, ETC. OF EACH UNDERGROUND OR OVERHEAD UTILITY. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH ALL FEDERAL, STATE AND/OR LOCAL RULES, REGULATIONS, STANDARD AND SAFETY REQUIREMENTS. UTILITIES SHALL BE INSTALLED IN ACCORDANCE WITH THE APPLICABLE MUNICIPALITY OR UTILITY COMPANY STANDARDS. IN ALL CASES, THE MOST STRINGENT REQUIREMENT SHALL APPLY.
- DD. ALL SUPPORTS FOR EQUIPMENT, DEVICES OR FIXTURES SHALL BE UNIQUE, DIRECTLY FROM THE BUILDING STRUCTURE. DO NOT SUPPORT WORK FROM OTHER TRADES EQUIPMENT OR SUPPORTS WITHOUT WRITTEN PERMISSION FROM THE ENGINEER AND CONSENT OF THE OTHER TRADE, IN WRITING.
- EE. WHERE INTERRUPTING AN EXISTING UTILITY OR SERVICE DELIBERATELY OR ACCIDENTALLY, THE RESPONSIBLE CONTRACTOR SHALL WORK CONTINUOUSLY AS NEEDED TO RESTORE SAME, PROVIDING PREMIUM TIME AS NEEDED.
- FF. THIS CONTRACTOR SHALL BE RESPONSIBLE FOR ALL CUTTING AND PATCHING REQUIRED FOR HIS WORK. ALL CUTTING AND PATCHING SHALL BE IN ACCORDANCE WITH THE ARCHITECT'S STANDARDS FOR SUCH WORK.
- GG. ALL WORK SHALL BE CONCEALED UNLESS SPECIFICALLY INDICATED TO BE EXPOSED, OR REQUIRED TO BE EXPOSED, IF IN DOUBT, CONTACT THE ENGINEER FOR CLARIFICATIONS PRIOR TO INSTALLING ANY SUCH WORK.
- HH. INTERRUPTION OF ANY EXISTING SERVICES SHALL BE COORDINATED WITH THE OWNER, GENERAL CONTRACTOR, UTILITY COMPANY AS NECESSARY, AND THE ARCHITECT. AT LEAST TWO WEEKS IN ADVANCE OF ANTICIPATED INTERRUPTION, A SCHEDULE FOR THESE OUTAGES SHALL BE DEVELOPED AND AGREED UPON BETWEEN THE PARTIES MENTIONED TO AVOID UNNECESSARY INCONVENIENCE TO THE OWNER OR ANY AFFECTED PARTY. NOTIFY THE UTILITY COMPANY OF ANY ANTICIPATED INTERRUPTION REQUIRED TWO WEEKS IN ADVANCE, IN WRITING, IF UTILITY COMPANY REQUIRES A LONGER NOTIFICATION PERIOD, SO PROVIDE.
- II. JUNCTION BOXES LOCATED ABOVE ACCESSIBLE CEILINGS SHALL BE LOCATED NO MORE THAN 36" ABOVE CEILING LEVEL. LABEL EACH BOX IN AREA OF WORK WITH A PERMANENT MARKER OR IN ACCORDANCE WITH SPECIFICATIONS FOR SUCH LOCATIONS.
- JJ. ALL MATERIALS FURNISHED AND ALL WORK INSTALLED SHALL COMPLY WITH THE CURRENT EDITION OF THE NATIONAL ELECTRICAL CODES, NATIONAL FIRE CODES OF THE NATIONAL FIRE PROTECTION ASSOCIATION, THE REQUIREMENTS OF LOCAL UTILITY COMPANIES, AND WITH THE REQUIREMENTS OF ALL APPLICABLE AGENCIES OR DEPARTMENTS HAVING JURISDICTION. IF ANY CONFLICTS OR DISCREPANCIES OCCUR THE MOST STRINGENT SHALL APPLY.
- KK. DO NOT SCALE FROM DRAWINGS, AS PRINTING DISTORTS SCALE. WORK SHALL BE LAID OUT FROM DIMENSIONED DRAWINGS, OR DIMENSIONS SUPPLIED TO THE CONTRACTOR.
- LL. NOISY WORK, WORK OUTSIDE CONSTRUCTION BARRIERS, WORK IN OCCUPIED AREAS, ETC. SHALL BE PERFORMED AFTER HOURS OR ON WEEKENDS. COORDINATE EXACT SCHEDULING WITH FACILITY PRIOR TO CONSTRUCTION.

GENERAL NOTES (DEMOLITION)

- A. DOTTED LINES INDICATE ITEMS FOR REMOVAL (UNO) AND THIN SOLID LINES INDICATE EXISTING ITEMS TO REMAIN.
- B. THE CONTRACTOR SHALL MAINTAIN THE CONTINUITY OF EXISTING CIRCUITS THAT CONTAIN DEVICES OR EQUIPMENT THAT ARE TO REMAIN. WHEN DEMOLITION OF AN ELECTRICAL DEVICE (OR CIRCUIT) IS INDICATED ON THE DRAWINGS, THE CONTRACTOR SHALL ENSURE THAT OTHER DEVICES OR EQUIPMENT "UPSTREAM" OR "DOWNSTREAM" ON THE CIRCUITS SHALL REMAIN IN "PRE-DEMOLITION" WORKING ORDER. "LEFT-OVER" CIRCUIT BREAKERS SHALL REMAIN, BE SWITCHED TO OFF POSITION, AND BE LABELED AS SPARES IN THEIR PANELS. PROVIDE NEW TYPEWRITTEN DIRECTORIES FOR ALL PANELS AFFECTED.
- C. LOCATIONS OF DEVICES, CONNECTIONS, ETC., INDICATED ON THIS DRAWING WERE TAKEN FROM VARIOUS SOURCES. THEY ARE DIAGRAMMATIC ONLY AND ARE SUBJECT TO VARIATION FROM EXISTING CONDITIONS. CERTAIN EXISTING ELEMENTS MAY NOT BE INDICATED AT ALL. THE CONTRACTOR PROPOSING TO DO ANY PART OF THE WORK INDICATED HEREON SHALL VISIT THIS SITE AND DETERMINE TO HIS SATISFACTION THAT THEY MAY COMPLETE ALL WORK REQUIRED FOR THE BID WHICH HE PROPOSES.
- D. REMOVE ALL ASSOCIATED BREAKBOXES, CONDUIT AND CONDUCTORS FOR DEVICES / FIXTURES / ETC. BEING REMOVED (BACK TO SOURCE), WHETHER INDICATED OR NOT (UNO). CONTRACTOR SHALL PATCH AND REPAIR ANY EXISTING WALLS, FLOORS OR CEILINGS WHERE DEVICES ARE SHOWN TO BE REMOVED (PATCH AND REPAIR TO RECEIVE NEW FINISHES - SEE ARCHITECTURAL PLANS).
- E. COORDINATE DISPOSAL OF ALL FIXTURES, DEVICES, ETC. (INDICATED FOR DEMOLITION) WITH OWNER. TURN OVER ITEMS REMOVED TO OWNER AT THEIR OPTION.
- F. COORDINATE WITH OTHER TRADES FOR THE REMOVAL AND/OR RELOCATION OF ELECTRICAL DEVICES AND CONNECTIONS ASSOCIATED WITH THEIR EQUIPMENT.
- G. CONTRACTOR SHALL PATCH AND REPAIR ALL EXISTING WALLS / CEILINGS AS REQUIRED WHERE DEVICES ARE BEING REMOVED OR INSTALLED.
- H. UNUSED/ABANDONED CONDUCTORS DISCOVERED ABOVE ACCESSIBLE CEILINGS SHALL BE REMOVED IN ACCORDANCE WITH NEC REQUIREMENTS.
- I. EXISTING ELECTRICAL SYSTEMS IN CONFLICT WITH CONSTRUCTION SHALL BE RELOCATED TO PERMIT INSTALLATION OF DEVICES AND EQUIPMENT SHOWN ON PLANS.
- J. CONTRACTOR SHALL SEAL ALL EXISTING AND NEW PENETRATIONS OF BUILDING ENVELOPE (EXTERIOR WALLS, ROOF, ETC.) WATER-TIGHT AND AS APPROVED BY ARCHITECT AND ENGINEER. ROOFING SHALL BE RESTORED BY A LICENSED ROOFING CONTRACTOR BASED ON WRITTEN INSTRUCTIONS AND DETAILS FROM ROOFING MANUFACTURER AS REQUIRED TO MAINTAIN ROOF WARRANTY. REFER TO ARCHITECTURAL AND ENGINEERING PLANS AND SPECIFICATIONS OR FURTHER REQUIREMENTS.
- K. ALL EXISTING PANELS AFFECTED BY THIS CONTRACTOR'S WORK SHALL BE PROVIDED WITH NEW TYPE-WRITTEN PANEL DIRECTORIES AND INSERT SLEEVES. PANEL DIRECTORIES SHALL NOT USE ROOM NAMES OR NUMBERS FROM THESE DRAWINGS. DIRECTORIES SHALL BE DETAILED AND COORDINATED WITH OWNER'S SUITE NUMBERS. FINAL ROOM NUMBERS, IF RACK NAMES, WORKSTATION DESIGNATIONS, ETC., UNUSED BREAKERS SHALL BE IN OFF POSITION.
- L. CONTRACTOR SHALL COORDINATE WITH BUILDING OWNER/GENERAL CONTRACTOR FOR SCOPE OF WORK THAT NEEDS TO BE PERFORMED OUTSIDE OF THE SCOPE LIMITS.

GENERAL NOTES (POWER)

- A. REFER TO THE ARCHITECT'S REFLECTED CEILING PLANS, ELEVATIONS, AND CASEWORK DETAILS FOR EXACT LOCATIONS OF ALL WALL AND CEILING MOUNTED ELECTRICAL DEVICES.
- B. CONTRACTOR SHALL FOLLOW BRANCH CIRCUITING LAY-OUT, AS INDICATED ON THE FLOOR PLANS, WITH A MAXIMUM OF THREE (3) BRANCH CIRCUITS PER HOMERUN. EACH BRANCH SHALL BE PROVIDED WITH A DEDICATED NEUTRAL CONDUCTOR. DEDICATED NEUTRAL CONDUCTORS SHALL BE CONSIDERED CURRENT CARRYING. IF ADDITIONAL CONDUCTORS ARE RUN IN THE SAME CONDUIT WITH THOSE INDICATED, CONTRACTOR SHALL DERATE ALL CURRENT CARRYING CONDUCTORS PER NEC 310.15(B)(3), AND UPSIZE CONDUIT AS REQUIRED PER NEC 300.17 AND ANNEX C. MULTIWIRE BRANCH CIRCUITS AS DEFINED IN NEC 100 / 210.4 (CIRCUITS SHARING A COMMON NEUTRAL CONDUCTOR SHALL NOT BE PERMITTED).
- C. IDENTIFY THE PANEL AND CIRCUIT NUMBER FOR ALL RECEPTACLES, SWITCHES, ETC. IN AREA OF CONSTRUCTION. PROVIDE CLEAR ADHESIVE LABELS WITH BLACK LETTERING, MARK INSIDES OF ALL DEVICE BOXES WITH PANEL AND CIRCUIT NUMBER.
- D. LOCATIONS OF ELECTRICAL CONNECTIONS AND LOCAL DISCONNECTS SHALL BE COORDINATED WITH MECHANICAL AND PLUMBING CONTRACTORS TO ENSURE ACCESS AND WORKING CLEARANCE IS MAINTAINED PER NEC. NOTIFY OTHER TRADES OF REQUIRED CLEARANCE AREAS TO AVOID ROUTING OF OTHER SYSTEMS IN THESE AREAS. DO NOT INSTALL ELECTRICAL EQUIPMENT OVER EQUIPMENT NAMEPLATES OR ACCESS PANELS OR THROUGH ACCESS/MAINTENANCE CLEARANCES OF EQUIPMENT BY OTHER TRADES.

LOAD SUMMARY:

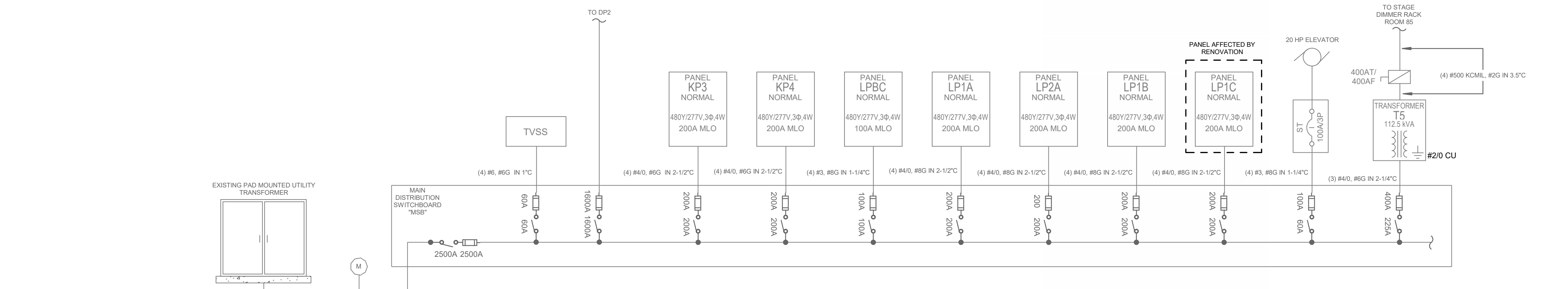
- EXISTING PANELBOARD L1FC
  - EXISTING LOAD = 164.8 kW
  - REMOVED LOAD = 12.0 kW
  - NEW LOAD = 96.3 kW
  - TOTAL LOAD = 139.1 kW (162.2 AMPS, @480/277V, 3Ø)
  - IN SUMMARY THIS PANELBOARD HAS BUSING AND FEEDERS SUFFICIENT FOR THE RENOVATION.
- EXISTING SWITCHBOARD H1B
  - EXISTING LOAD = 163.0 kW
  - REMOVED LOAD = 12.0 kW
  - NEW LOAD = 96.3 kW
  - TOTAL LOAD = 191.3 kW (154 AMPS, @480/277V, 3Ø)
  - IN SUMMARY THIS SWITCHBOARD HAS BUSING AND FEEDERS SUFFICIENT FOR THE RENOVATION.

| DESCRIPTION  | MOUNTING HEIGHT TO CENTER OF BOX | DRAWING SYMBOL |
|--|----------------------------------|----------------|
| <b>SWITCHES</b>  |                                  |                |
| LIGHT SWITCH GENERAL PURPOSE   | 48"                              | \$             |
| OCCUPANCY SENSOR SWITCH  | 48"                              | 80C            |
| LOW VOLTAGE MOMENTARY SWITCH   | 48"                              | 5 M            |
| NON-REVERSING MOTOR STARTER SNAP SWITCH  | AS NOTED                         | \$ M           |
| OCCUPANCY SENSOR, CEILING MOUNT  | CLG                              | Ⓞ              |
| PHOTOCELL / DAYLIGHT SENSOR  | CLG                              | Ⓞ              |
| EMERGENCY LIGHTING RELAY DEVICE  | CLG                              | ER             |
| NOTE: REFER TO LIGHTING CONTROL DEVICE SCHEDULE FOR OTHER DEVICE CONFIGURATIONS  |                                  |                |
| <b>POWER OUTLETS</b>   |                                  |                |
| DUPLEX RECEPTACLE-SAFETY TYPE, TAMPER-RESISTANT  | 1'-6"                            | Ⓢ              |
| DUPLEX RECEPTACLE-SAFETY TYPE, TAMPER-RESISTANT, SWITCHED CIRCUIT  | 1'-6"                            | Ⓢ              |
| SLASH THROUGH ANY DEVICE INDICATES MOUNTING ABOVE COUNTERTOP 4" ABOVE BACKSPLASH, OR AT 46" WHERE NO COUNTER IS PRESENT                                | 1'-6"                            | Ⓢ              |
| FILLED CENTER BAR INDICATES INTEGRAL GROUND (GFCI)   | 1'-6"                            | Ⓢ              |
| QUADRUPLX RECEPTACLE   | 1'-6"                            | Ⓢ              |
| JUNCTION BOX, CEILING OR WALL  |                                  | Ⓜ              |
| DUPLEX FOR ELECTRIC WATER COOLER   |                                  | Ⓜ              |
| COORDINATE EXACT LOCATION WITH PLUMBING CONTRACTOR TO CONICAL GUFLET BEHIND COOLER. PROVIDE READY ACCESSIBLE OF DEVICE AT 18" ADJACENT TO WATER COOLER |                                  | Ⓜ              |
| <b>FIRE ALARM</b>  |                                  |                |
| PULL STATION: DOUBLE ACTION WITH POLYCARBONATE COVER AND WARNING SOUNDER   | 48" TO LEVER                     | F              |
| AUDIO/VISUAL NOTIFICATION APPLIANCE  | WALL, CLG                        | F              |
| VISUAL-ONLY NOTIFICATION APPLIANCE   | WALL, CLG                        | V              |
| PHOTO-ELECTRIC SMOKE DETECTOR  | CLG                              | SD             |

| DESCRIPTION  | MOUNTING HEIGHT TO CENTER OF BOX | DRAWING SYMBOL |
|--|----------------------------------|----------------|
| <b>LIGHTING</b>  |                                  |                |
| SURFACE OR SUSPENDED CEILING FIXTURE (SLASH INDICATES RECEIVED)  |                                  | Ⓢ              |
| EXIT LIGHT (CEILING, END, WALL MOUNT)  |                                  | Ⓢ              |
| STRIP FIXTURE  |                                  | Ⓢ              |
| PARALLEL-HATCHING INDICATES LIGHT IS POWERED FROM THE EMERGENCY-LIFE SAFETY BRANCH   |                                  | Ⓢ              |
| NOTE: REFER TO LUMINAIRE SCHEDULE FOR EXACT FIXTURE SPECIFICATIONS, MOUNTING HEIGHTS, ETC.   |                                  | Ⓢ              |
| <b>MISCELLANEOUS</b>   |                                  |                |
| CONDUIT CONCEALED IN WALLS OR IN CEILING SPACE: (ARROWS) INDICATE(S) HOME RUN & # OF CIRCUITS. HASHMARKS INDICATE # OF CONDUCTORS. DASHED LINE INDICATES CONDUIT UNDER SLAB, BELOW GRADE, OR IN CEILING SPACE OF FLOOR BELOW.  |                                  | Ⓢ              |
| DISCONNECT SWITCH, SLASH INDICATES FUSED   | 5'-0"                            | Ⓢ              |
| PANELBOARD, SURFACE OR FLUSH MOUNTED, HATCHING INDICATES EMERGENCY   | 6'-6" TO TOP                     | Ⓢ              |
| TRANSFORMER  | AS NOTED                         | Ⓢ              |
| THERMOSTAT PROVIDED BY MECHANICAL CONTRACTOR. ELECTRICAL CONTRACTOR SHALL PROVIDE BACK-BOX CONDUIT STUB-UP. REFER TO MECHANICAL DRAWINGS FOR LOCATIONS   |                                  | Ⓢ              |
| EQUIPMENT TAG, REFER TO EQUIPMENT SCHEDULE   |                                  | EQUIP-1        |
| TAGGED NOTE  |                                  | Ⓢ              |
| REVISION TAG   |                                  | Ⓢ              |
| INDICATES EMERGENCY POWER  |                                  | E.E.M          |
| <b>PANEL FURNITURE</b>   |                                  |                |
| POWER CONNECTION TO PANEL FURNITURE. PROVIDE SEAL-TIGHT CONDUIT CONNECTION FROM RECESSED WALL BOX TO PANEL FURNITURE. PROVIDE FINAL CONNECTIONS TO PANEL FURNITURE AS REQUIRED BY PANEL FURNITURE VENDOR   | 1'-6"                            | FF             |
| <b>SECURITY ACCESS CONTROL AND VIDEO SURVEILLANCE</b>  |                                  |                |
| KEY PAD STATION  |                                  | Ⓢ              |
| CARD READER STATION  |                                  | Ⓢ              |
| SOUND MASKING SPEAKER- WALL  |                                  | Ⓢ              |
| PEDESTAL MOUNTED CARD READER STATION   |                                  | Ⓢ              |
| ANTENNA  |                                  | Ⓢ              |
| <b>DATA / VOICE</b>  |                                  |                |
| DATA OUTLET: NUMBER BESIDE OUTLET INDICATES NUMBER OF DATA JACKS   | 1'-6"                            | Ⓢ              |
| SLASH THROUGH DEVICE INDICATES MOUNTING ABOVE COUNTERTOP 4" ABOVE BACKSPLASH, OR AT 46" WHERE NO COUNTER IS PRESENT  |                                  | Ⓢ              |
| WIRELESS ACCESS POINT WITH (2) CAT5A CABLES WITH FIELD TERMINATED MODULAR PLUGS. PROVIDE BY COIL ABOVE ACCESSIBLE CEILING FOR ADJUSTMENT OF FINAL LOCATION. PROVIDE RACEWAY AND JUNCTION BOX TO CONTAIN SLACK COIL IN AREAS WITH NO ACCESSIBLE CEILING. THE CONTRACTOR SHALL COORDINATE EXACT LOCATIONS WITH THE OWNER AND ADJUST FINAL LOCATIONS PRIOR TO SUBSTANTIAL COMPLETION. |                                  | Ⓢ              |
| CEILING MOUNTED CAMERA   |                                  | Ⓢ              |
| WALL MOUNTED CAMERA  |                                  | Ⓢ              |

| DESCRIPTION   | MOUNTING HEIGHT TO CENTER OF BOX | DRAWING SYMBOL |
|---|----------------------------------|----------------|
| <b>ABBREVIATIONS</b>  |                                  |                |
| UNLESS OTHERWISE NOTED  |                                  | UNO            |
| OWNER FURNISHED CONTRACTOR INSTALLED  |                                  | OF CI          |
| OWNER FURNISHED - OWNER INSTALLED   |                                  | OF CI          |
| CONTRACTOR FURNISHED CONTRACTOR INSTALLED   |                                  | OF CI          |
| CONTRACTOR FURNISHED - OWNER INSTALLED  |                                  | OF CI          |
| INDICATES EMERGENCY POWER   |                                  | E.M            |
| ALL DEVICES INDICATED WITH "WG" SHALL BE PROVIDED WITH WIREGUARD FOR PROTECTION   |                                  | WG             |
| <b>SPECIAL OUTLETS</b>  |                                  |                |
| FLOORBOX, POWER ONLY, AS SCHEDULED  | FLOOR                            | Ⓢ              |
| FLOORBOX OR POKE THRU: COMBINATION POWER AND LOW VOLTAGE, COORDINATE FIRE RATING AND COVER REQUIREMENTS WITH ARCHITECTURAL FINISHES. ROUTE CONDUITS FOR POWER AND LOW VOLTAGE UNDER FLOOR SLAB TO NEAREST WALL, U.O.N. REFER TO DETAILS AND FLOORBOX SCHEDULE.  | FLOOR                            | Ⓢ              |
| COMBINATION POWER AND DATA OUTLET   | 1'-6"                            | Ⓢ              |
| COMBINATION POWER AND DATA OUTLET ABOVE COUNTER   |                                  | Ⓢ              |
| COMBINATION POWER AND DATA OUTLET WITH GFCI DUPLEX RECEPTACLE   | 1'-6"                            | Ⓢ              |
| NOTE: WHERE PLANS SHOW NEW DEVICES ON EXISTING BLOCK WALLS, CONTRACTOR SHALL PROVIDE RECESSED BOX AND ROUTE CABLING IN CONDUIT INSIDE THE EXISTING WALL, WHERE OBSTRUCTIONS OR FILLED CONCRETE BLOCK ARE PRESENT. CONTRACTOR SHALL PROVIDE METAL SURFACE WIREWAY AND SECURELY FASTENED WITH TWO-HOLE STRAPS. OUTLET BOXES FOR USE WITH SURFACE WIREWAY SHALL BE A MINIMUM OF 1-3/8" DEEP. PROVIDE THE FOLLOWING STEEL WIREWAYS WITH A MAXIMUM OF 40% FILL: <ul style="list-style-type: none"> <li>POWER (MAX 3 CIRCUITS): WIREMOLD 700 SERIES</li> <li>POWER (MAX 5 CIRCUITS): WIREMOLD 2100 SERIES</li> <li>DATA (MAX 2 CAT5 CABLES): WIREMOLD 700 SERIES</li> <li>DATA (MAX 4 CAT5 CABLES): WIREMOLD 2100 SERIES</li> </ul> |                                  |                |
| <b>INTERCOM/OVERHEAD PAGING</b>   |                                  |                |
| SOUND MASKING SPEAKER- CEILING  | CLG                              | Ⓢ              |
| SOUND MASKING SPEAKER- WALL   | CLG                              | Ⓢ              |
| ANTENNA   | CLG                              | Ⓢ              |
| <b>DEVICE COLOR MATRIX</b>  |                                  |                |
| WHITE   | ●                                |                |
| INDICATES COLOR NOT AVAILABLE   | ●                                |                |
| INDICATES COLOR NOT SELECTED  | ●                                |                |

| DESCRIPTION  | SYSTEM RESPONSIBILITY MATRIX | SYSTEM SYMBOL |
|--|------------------------------|---------------|
| <b>SYSTEM RESPONSIBILITY MATRIX</b>  |                              |               |
| PATHWAYS   | ●                            | ●             |
| DEVICES - OF CI  | ●                            | ●             |
| DEVICES - OF CI  | ●                            | ●             |
| DEVICES - OF CI  | ●                            | ●             |
| CABLE/CONDUCTORS - OF CI   | ●                            | ●             |
| CABLE/CONDUCTORS - OF CI   | ●                            | ●             |
| CABLE/CONDUCTORS - OF CI   | ●                            | ●             |
| <b>SYSTEM</b>  |                              |               |
| FIRE ALARM   | ●                            | ●             |
| SYSTEM RESPONSIBILITY GENERAL NOTES:   |                              |               |
| A. REFER TO VENDOR DRAWINGS FOR COMPLETE SCOPE OF WORK RELATING TO VENDOR-FURNISHED EQUIPMENT. ALL WORK INDICATED ON VENDOR DRAWINGS SHALL BE INCLUDED BY THE CONTRACTOR.  |                              |               |
| B. REFER TO ARCHITECTURAL DOOR HARDWARE SPECIFICATIONS FOR ACCESS CONTROL DEVICE SPECIFICATIONS AND FURTHER REQUIREMENTS.  |                              |               |
| C. PROVIDE BACKBOXES AND CONDUIT WITH FULL STRINGS FOR ALL SYSTEMS. CONTRACTOR SHALL VERIFY BACKBOX SIZES, CONDUIT, ETC. AND EXACT INSTALLATION LOCATION REQUIREMENTS WITH SUCCESSFUL VENDORS OF ALL SYSTEMS PRIOR TO CONSTRUCTION. PROVIDE A BLANK FACEPLATE FOR ALL SYSTEMS WHERE EQUIPMENT IS GFCI.   |                              |               |
| D. AT ALL SYSTEMS EQUIPMENT CABINET/TERMINAL BOARD LOCATIONS, CONTRACTOR SHALL PROVIDE SIZE AND NUMBER OF CONDUIT SUB-CUTS TO CABLE PATHS AS REQUIRED BY SYSTEM VENDORS. TERMINATE CONDUITS AT CABINET/BACKBOARDS AS REQUIRED. COORDINATE EXACT REQUIREMENTS WITH APPROPRIATE VENDORS PRIOR TO CONSTRUCTION.   |                              |               |
| E. REFER TO SPECIFICATIONS FOR REQUIREMENTS APPLICABLE TO ALL SYSTEMS INCLUDING CABLING, CABLE MANAGEMENT, INSTALLATION, GROUNDING, TESTING, LABELING, ETC.  |                              |               |
| F. WHERE INDICATED AS GFCI, THE CONTRACTOR SHALL PROVIDE THE SYSTEM COMPLETE, INCLUDING ALL ROUGHINS, CABLING, DEVICES, POWER, ETC. THE CONTRACTOR SHALL CONTACT THE LISTED VENDOR FOR PRICING PRIOR TO BID. NEW COMPONENTS SHALL BE INTERCONNECTED WITH EXISTING SYSTEMS WHERE POSSIBLE. ALL NEW SYSTEM DESIGNS AND PROGRAMMING SHALL BE COORDINATED WITH THE OWNER PRIOR TO ORDERING. ALL PROGRAMMING SHALL BE INCLUDED AS REQUIRED BY THE OWNER, PROVIDE MINIMUM 4 HOURS OF TRAINING FOR EACH SYSTEM UNO. |                              |               |
| <b>DESCRIPTION</b>   |                              |               |
| <b>DEVICE COLOR MATRIX</b>   |                              |               |
| WHITE  | ●                            |               |
| INDICATES COLOR NOT AVAILABLE  | ●                            |               |
| INDICATES COLOR NOT SELECTED   | ●                            |               |
| <b>DEVICE</b>  |                              |               |
| THERMOSTATS (COORDINATE WITH HVAC TYPICALLY NO COLOR OPTIONS)  | ●                            |               |
| RECEPTACLE (NORMAL)  | ●                            |               |
| FIRE ALARM DEVICES   | ●                            |               |
| WALL SWITCHES  | ●                            |               |
| <b>DEVICE COVERPLATES</b>  |                              |               |
| <b>DEVICE COLOR GENERAL NOTES:</b>   |                              |               |
| A. INDICATES COLOR NOT AVAILABLE UNLESS NOTED OTHERWISE.   |                              |               |
| B. NOT ALL DEVICES MAYBE USED THAT ARE SHOWN.  |                              |               |
| C. IF DEVICE COLOR NOT DEFINED REFER TO SPECIFICATIONS.  |                              |               |
| <b>LEGEND</b>  |                              |               |
| ● INDICATES SELECTED COLOR   |                              |               |
| ● INDICATES COLOR NOT AVAILABLE  |                              |               |
| ● INDICATES COLOR NOT SELECTED   |                              |               |



ELECTRICAL SINGLE LINE  
NOT TO SCALE

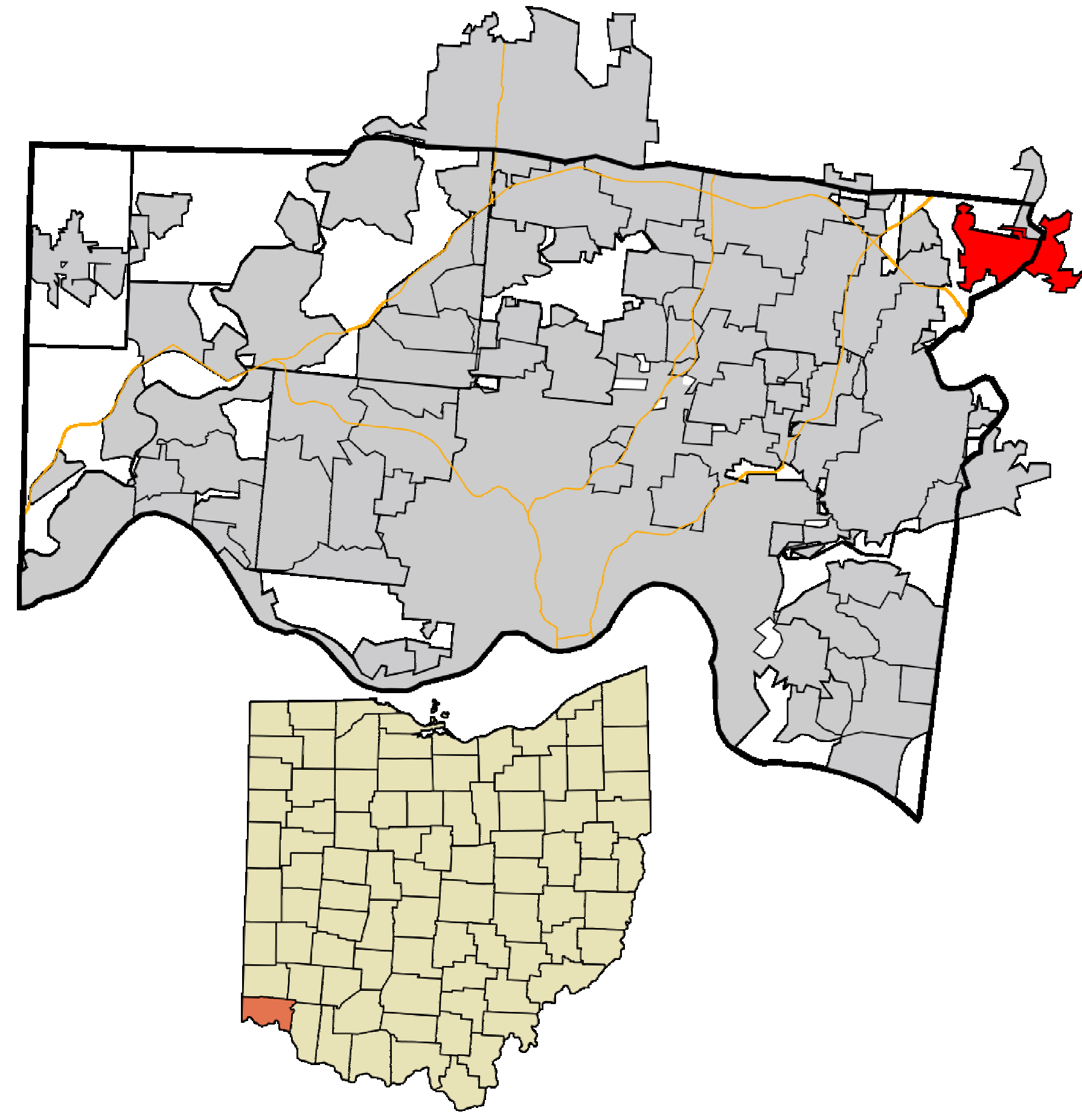
| PANELBOARD AND WIRING SCHEDULE       |      |                      |    |                            |     | AVAILABLE FAULT CURRENT: EXISTING PANEL |       |     |                                      |   |                         |
|--------------------------------------|------|----------------------|----|----------------------------|-----|---|-------|-----|--------------------------------------|---|-------------------------|
| PANEL: LP1C                          |      | MAINS TYPE: 200A MLO |    | PANEL INTERRUPTING RATING: |     | LOCATION:                               |       |     |                                      |   |                         |
| VOLTAGE: 480Y/277V, 3P, 4W           |      | SPD:                 |    | MOUNTING: FLUSH            |     | SUPPLY FROM:                            |       |     |                                      |   |                         |
| AMPERES: 200 A                       |      |                      |    |                            |     |   |       |     |                                      |   |                         |
| CIRCUIT DESCRIPTION                  | CB.. | OCF                  | P  | CKT                        | A   | C                                       | CKT P | OCF | CIRCUIT DESCRIPTION                  |   |                         |
| E-EXISTING - HALL LIGHTS             | 20   | 1                    | 1  | 2                          | 3.5 | 3.5                                     | 2     | 1   | E- LIGHTING - ROOM 123KIT/KITCHEN RR |   |                         |
| E-EXISTING - HALL LIGHTS             | 20   | 1                    | 3  | 1                          | 3.5 | 3.5                                     | 4     | 1   | E-EXISTING                           |   |                         |
| E-EXISTING - 7TH GRADE - ROOM 41     | 20   | 1                    | 5  |                            |     |   | 3.5   | 3.5 | 6                                    | 1 | E-EXISTING              |
| E-EXISTING - 7TH GRADE - ROOM 39A0   | 20   | 1                    | 7  |                            | 3.5 | 3.5                                     |       |     | 8                                    | 1 | E- LIGHTING - ROOM 82   |
| E-EXISTING - RESTROOMS/CLINIC/RECEPT | 20   | 1                    | 9  |                            |     | 3.5                                     | 3.5   |     | 10                                   | 1 | E- LIGHTING - BAND ROOM |
| E-SPARE                              | 20   | 1                    | 11 |                            |     |   | 0     | 0   | 12                                   | 1 | E-EXISTING              |
| E-SPARE                              | 20   | 1                    | 13 | 0.0                        | 3.5 |   |       |     | 14                                   | 1 | E-EXISTING              |
| E-SPARE                              | 20   | 1                    | 15 |                            |     | 0.0                                     | 0.0   |     | 16                                   | 1 | E-SPARE                 |
| E-SPARE                              | 20   | 1                    | 17 |                            |     |   | 0.0   | 0.0 | 18                                   | 1 | E-SPARE                 |
| E-SPARE                              | 20   | 1                    | 19 | 0.0                        | 0.0 |   |       |     | 20                                   | 1 | E-SPARE                 |
| E-SPARE                              | 20   | 1                    | 21 |                            |     | 0.0                                     | 0.0   |     | 22                                   | 1 | E-SPARE                 |
| E-SPARE                              | 20   | 1                    | 23 |                            |     |   | 0.0   | 0.0 | 24                                   | 1 | E-SPARE                 |
| E-SPARE                              | 20   | 1                    | 25 | 0.0                        | 0.0 |   |       |     | 26                                   | 1 | E-SPARE                 |
| E-SPARE                              | 20   | 1                    | 27 |                            |     | 0.0                                     | 0.0   |     | 28                                   | 1 | E-SPARE                 |
| E-SPARE                              | 20   | 1                    | 29 |                            |     |   | 0.0   | 0.0 | 30                                   | 1 | E-SPARE                 |
| E-SPARE                              | 20   | 1                    | 31 | 0.0                        | 0.0 |   |       |     | 32                                   | 1 | E-SPARE                 |
| E-SPARE                              | 20   | 1                    | 33 |                            |     | 0.0                                     | 0.0   |     | 34                                   | 1 | E-SPARE                 |
| E-SPARE                              | 20   | 1                    | 35 |                            |     |   | 0.0   | 0.0 | 36                                   | 1 | E-SPARE                 |
| AHU                                  |      |                      |    |                            |     |   |       |     |                                      |   |                         |



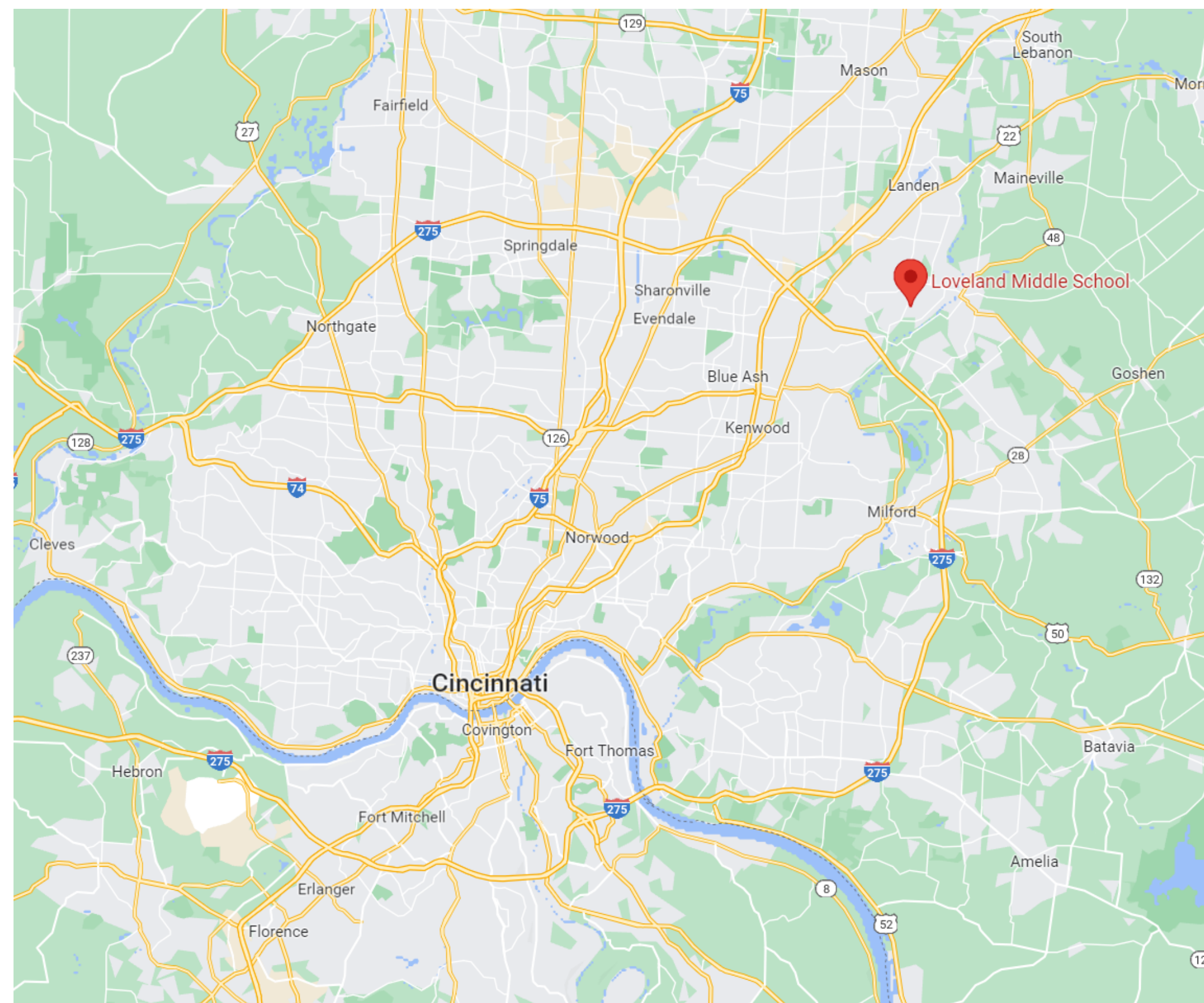


PROJECT LOCATION

VICINITY MAP: STATE



VICINITY MAP: CITY



GENERAL INFORMATION

GOVERNING REGULATIONS

- OHIO BUILDING CODE .....2024
- INTERNATIONAL MECHANICAL CODE.....2024
- INTERNATIONAL ENERGY CONSERVATION CODE.....2021
- NATIONAL ELECTRICAL CODE (NEC)NFPA 70 .....2022

PROJECT DESCRIPTION

THIS PROJECT CONSISTS OF THE REPLACEMENT OF TWO EXISTING AIR HANDLING UNITS WITH CHILLED WATER COILS FOR COOLING AND HEATING HOT WATER COILS FOR COOLING. THE UNITS ARE BEING REPLACED WITH NEW UNITS WITH HEATING HOT WATER COILS AND DX COOLING TO ALLOW FOR COOLING IN THE WINTER. UNITS ARE TO BE REPEF FROM EXISTING PANELS. DUE TO THE INCREASED WEIGHT OF THE UNITS SOME STRUCTURAL REINFORCEMENT WORK IS ALSO REQUIRED.



**Loveland**  
CITY SCHOOL DISTRICT

**LOVELAND MIDDLE SCHOOL AHU REPLACEMENT**

LOVELAND CITY SCHOOL DISTRICT  
801 S Lebanon Rd, Loveland, OH 45140

BID DOCUMENTS  
12/11/2024

LOVELAND PROJECT MANAGER : RICH BRYANT  
CMTA Project Manager: OWEN GREEN  
(OGREEN@CMTA.COM)



BUILDING SCIENCE LEADERSHIP



BID DOCUMENTS

LOVELAND MIDDLE SCHOOL AHU REPLACEMENT

LOVELAND CITY SCHOOL DISTRICT  
801 S Lebanon Rd, Loveland, OH 45140

COVER SHEET

|                    |            |
|--------------------|------------|
| CLIENT/CMTA JOB #: | OLMS23     |
| DATE:              | 12/11/2024 |
| DRAWN:             | OTG        |
| CHECKED:           | TLA        |

REVISIONS

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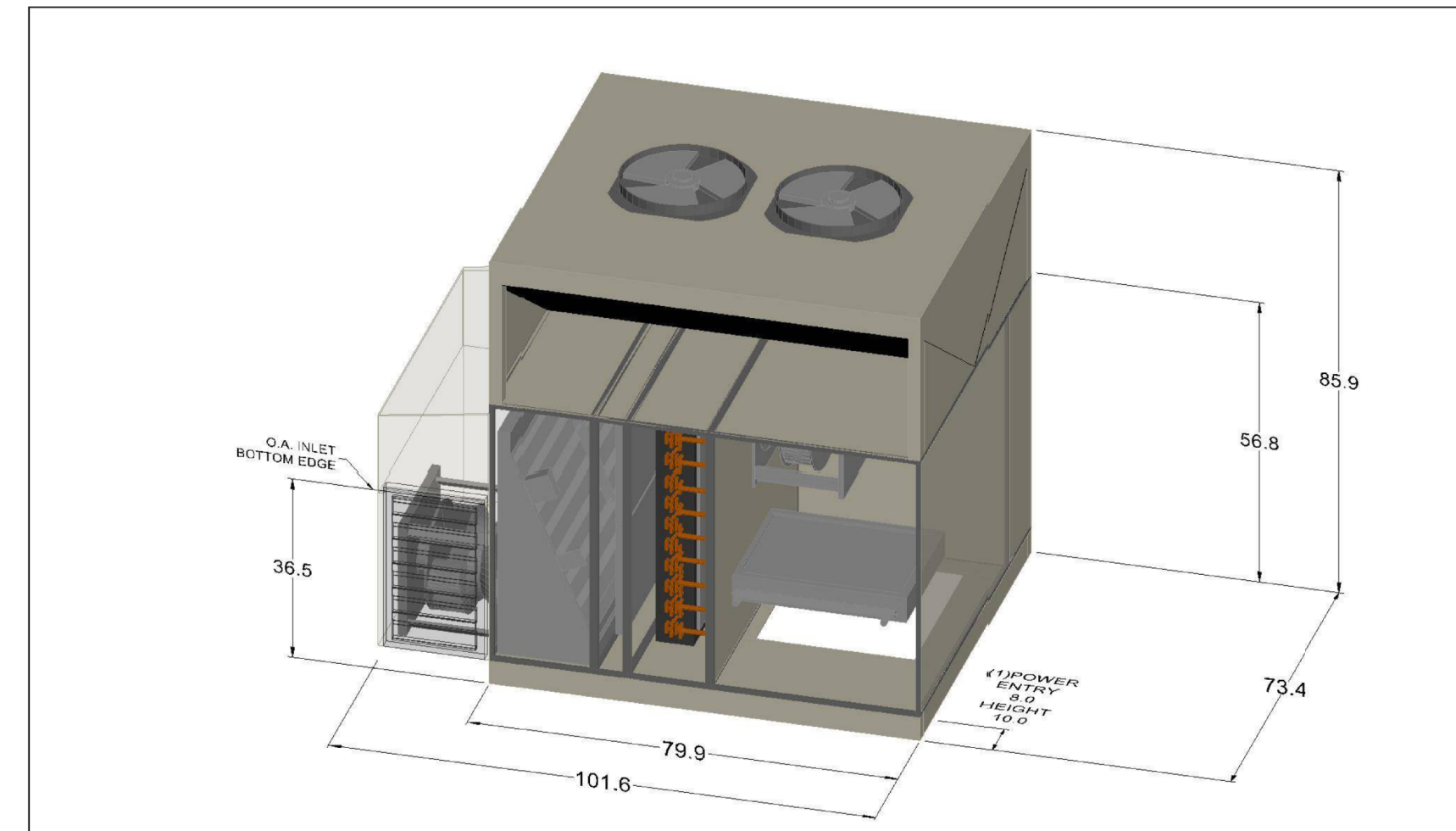




PACKAGED ROOFTOP UNIT SCHEDULE

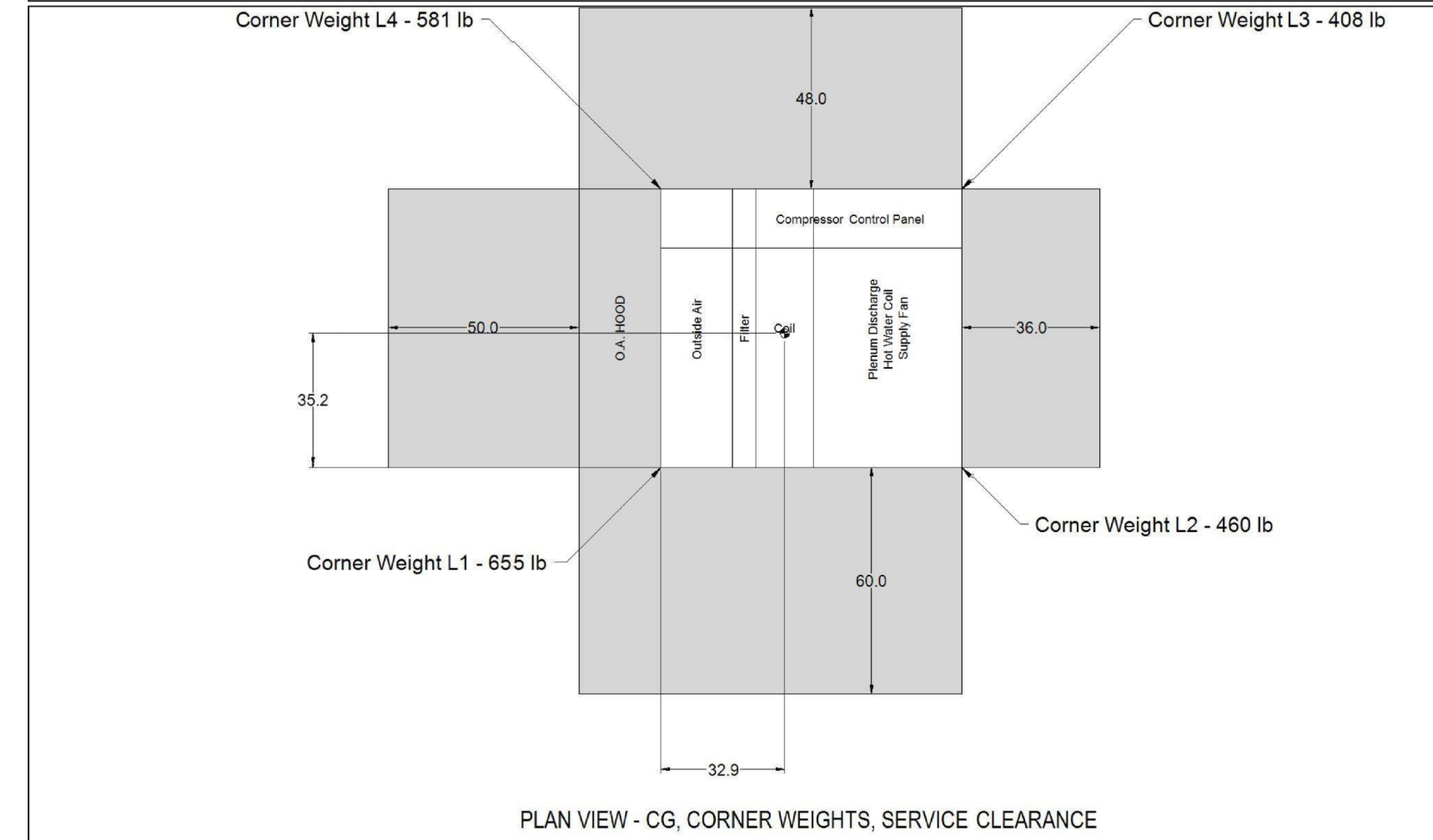
| MARK  | MANUFACTURER | MODEL | SERVICE    | DIMENSIONS   |             |              | WEIGHT (LBS) | RETURN/EXHAUST FAN |          | COOLING PERFORMANCE |           |           |              |             |                      | HEATING PERFORMANCE     |                 |                |      |      |                  | DISCHARGE SOUND POWER (DB) |           |           |            |                   |                        | ELECTRICAL           |            |       |        |        | REMARKS |        |         |         |         |         |         |       |      |      |      |      |      |
|-------|--------------|-------|------------|--------------|-------------|--------------|--------------|--------------------|----------|---------------------|-----------|-----------|--------------|-------------|----------------------|-------------------------|-----------------|----------------|------|------|------------------|----------------------------|-----------|-----------|------------|-------------------|------------------------|----------------------|------------|-------|--------|--------|---------|--------|---------|---------|---------|---------|---------|-------|------|------|------|------|------|
|       |              |       |            | LENGTH (IN.) | WIDTH (IN.) | HEIGHT (IN.) |              | FAN TYPE           | QUANTITY | HORSEPOWER          | TOTAL CFM | ESP (IN.) | COOLING TYPE | REFRIGERANT | TOTAL CAPACITY (MBH) | SENSIBLE CAPACITY (MBH) | ENTERING (DBWB) | LEAVING (DBWB) | EER  | IEER | FAN TYPE         | QUANTITY                   | TOTAL CFM | ESP (IN.) | HORSEPOWER | HEATING TYPE      | HEATING CAPACITY (MBH) | WATER TEMP (EWT/LWT) | FLOW (GPM) | 63 HZ | 125 HZ | 250 HZ |         | 500 HZ | 1000 HZ | 2000 HZ | 4000 HZ | 8000 HZ | VOLTAGE | PHASE | FLA  | MCA  | MOCP | SCCR |      |
| AH-6  | DAIKIN       | DPS31 | STAGE      | 101.6        | 73.4        | 85.9         | 2105         | ECM-DIRECT DRIVE   | 1        | 1.7                 | 2400      | 0.5       | DX           | R-32        | 94.7                 | 86.0                    | 80.0/67.0       | 53.5/53.5      | 13.4 | 20.8 | ECM-DIRECT DRIVE | 1                          | 2400      | 1.0       | 1.7        | HEATING HOT WATER | 118.8                  | 180/150              | 8.0        | 72    | 74     | 82     | 79      | 82     | 81      | 78      | 73      | 88      | 480     | 3     | 24.4 | 27.6 | 40   | 10   | 1-12 |
| AH-11 | DAIKIN       | DPS37 | AUDITORIUM | 202.5        | 76.5        | 72.1         | 4035         | ECM-DIRECT DRIVE   | 1        | 6.1                 | 10000     | 0.5       | DX           | R-32        | 381.4                | 296.0                   | 80.0/67.0       | 55.4/54.1      | 10.2 | 16.9 | VFD-DIRECT DRIVE | 1                          | 10000     | 1.0       | 10.0       | HEATING HOT WATER | 502.2                  | 180/150              | 34.1       | 64    | 63     | 88     | 83      | 81     | 78      | 73      | 88      | 480     | 3       | 84.4  | 92.2 | 110  | 10   | 1-12 |      |

- REMARKS:**
- MODULATING HOT GAS REHEAT WITH COMBINATION SPACE TEMPERATURE AND HUMIDITY SENSOR.
  - 2" MERV 13 FILTER AND RACK
  - DUCT MOUNTED CO2 SENSOR.
  - NON-FUSED DISCONNECT SWITCH.
  - UNIT POWERED CONVENIENCE OUTLET.
  - PHASE FAILURE MONITOR.
  - OUTSIDE AIR STATIC PRESSURE TIP (DWYER A-306).
  - OUTSIDE AIR HUMIDITY SENSOR WITH SUNSCREEN.
  - FREEZESTAT.
  - PROVIDE NEW CURB FOR EXISTING SLOPED ROOF.
  - PROVIDE FACTORY UNIT CONTROLLER. THE INTEGRATION OF THESE UNITS TO THE NEW BUILDING AUTOMATION SYSTEM SHALL BE DONE BY THE CONTROLS CONTRACTOR AS A PART OF THIS PROJECT. REFER TO THE SPECIFICATIONS FOR MORE INFORMATION.
  - THE UNITS SUBMITTED BY THE MECHANICAL CONTRACTOR MUST MEET THE SCHEDULED DISCHARGE SOUND POWER DATA AT A MINIMUM. ANY UNITS THAT ARE LOUDER THEN SCHEDULED ABOVE WILL BE REJECTED.

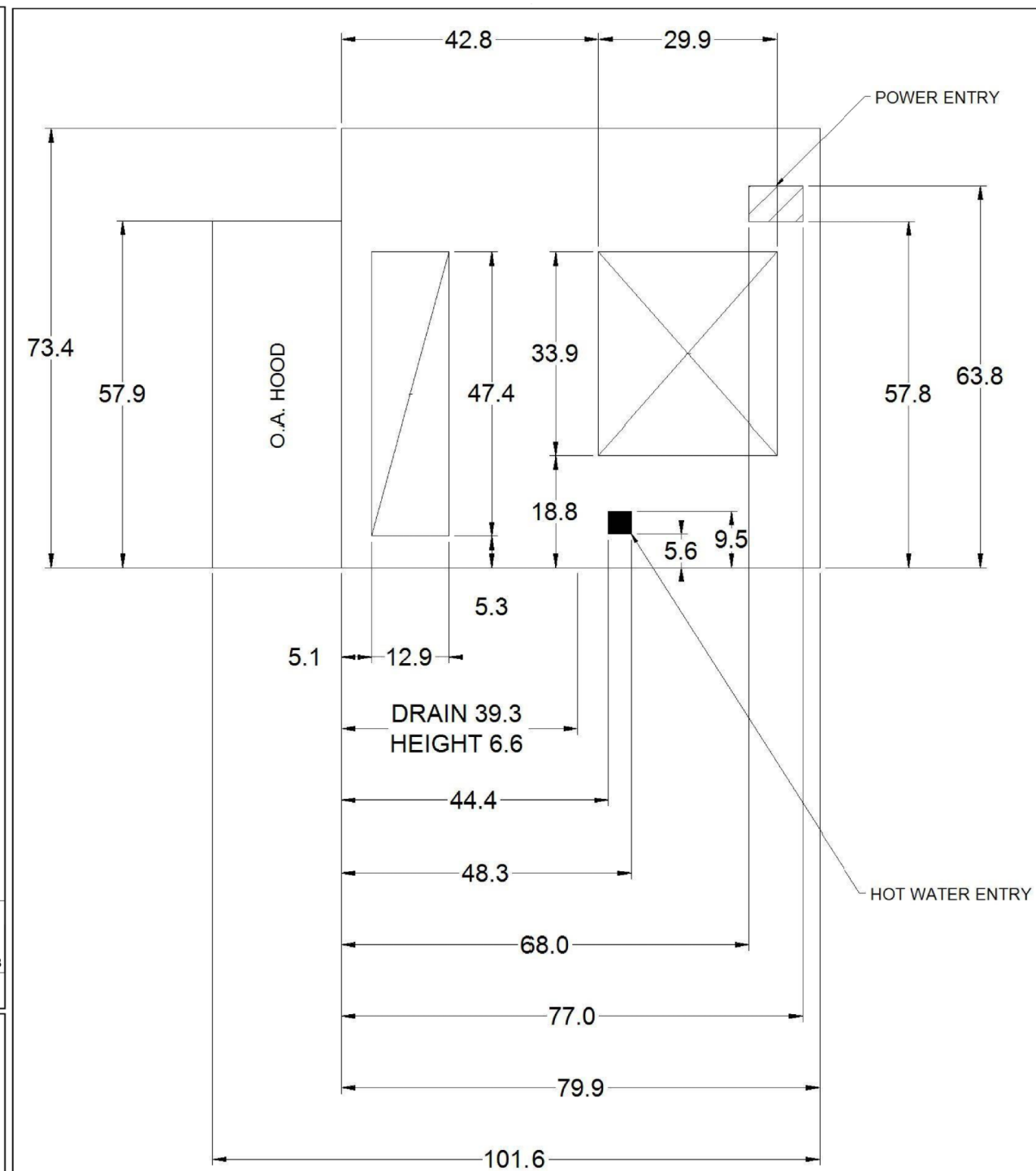


Notes:  
 (1) Recommended location for optional field cut side power connection.

Unit Tag: AH-6  
 Project Name: Loveland Middle School - AH-6 &  
 Model: DPS31  
 Sales Office: EIR/Am, Inc.  
 Sales Engineer: [Name]  
 13000 Industrial Park Blvd. Minneapolis, MN 55441  
 www.DaikinApplied.com Software Version: 12.83

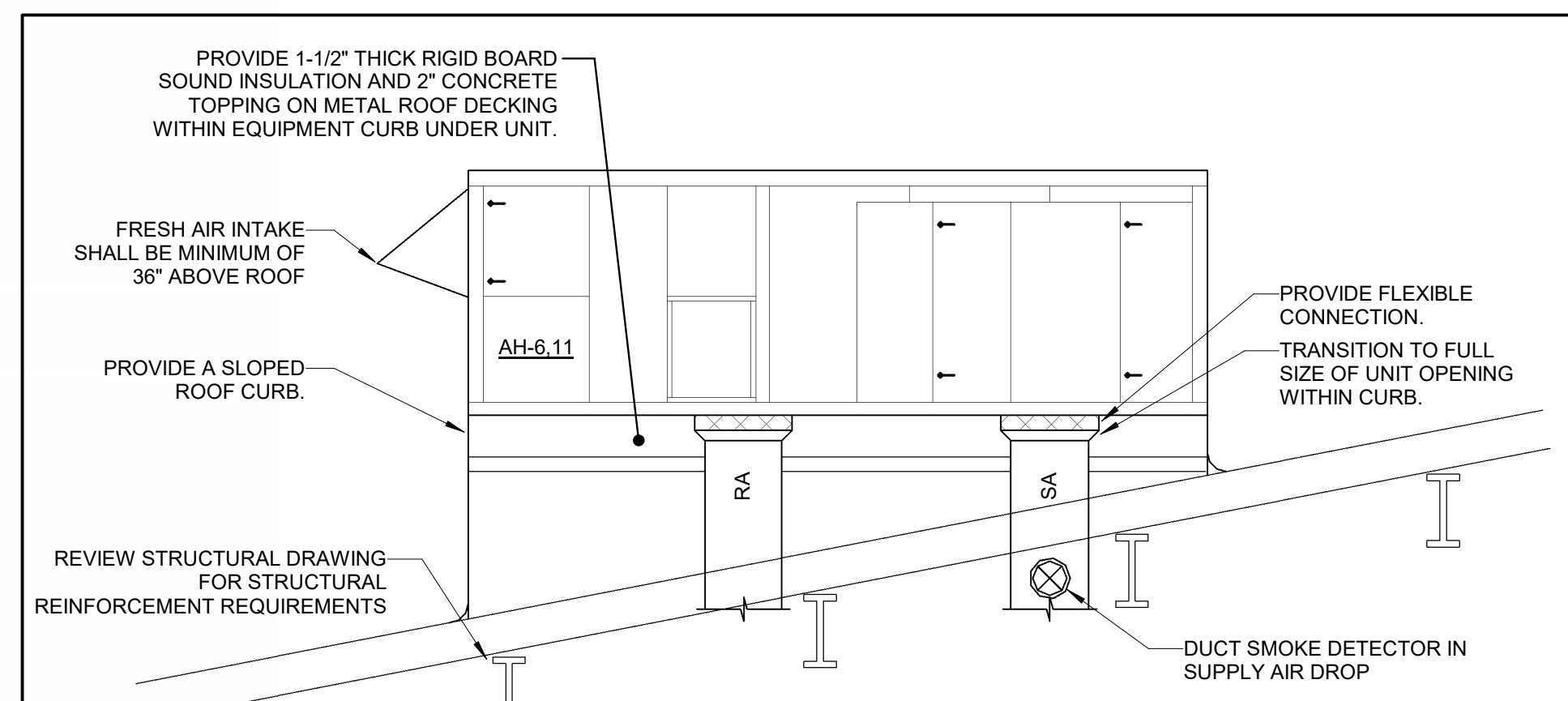


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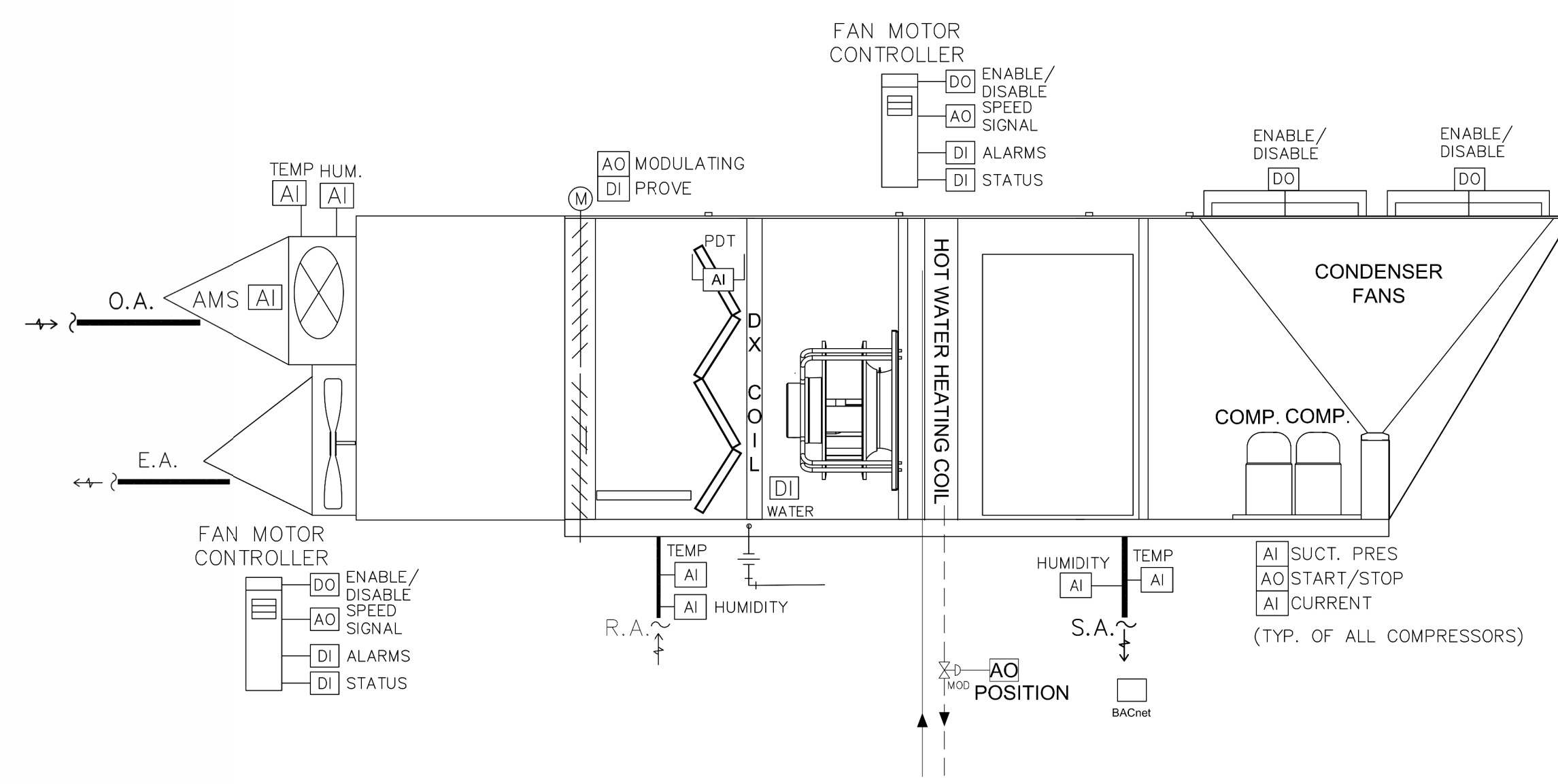
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 Project Name: Loveland Middle School -  
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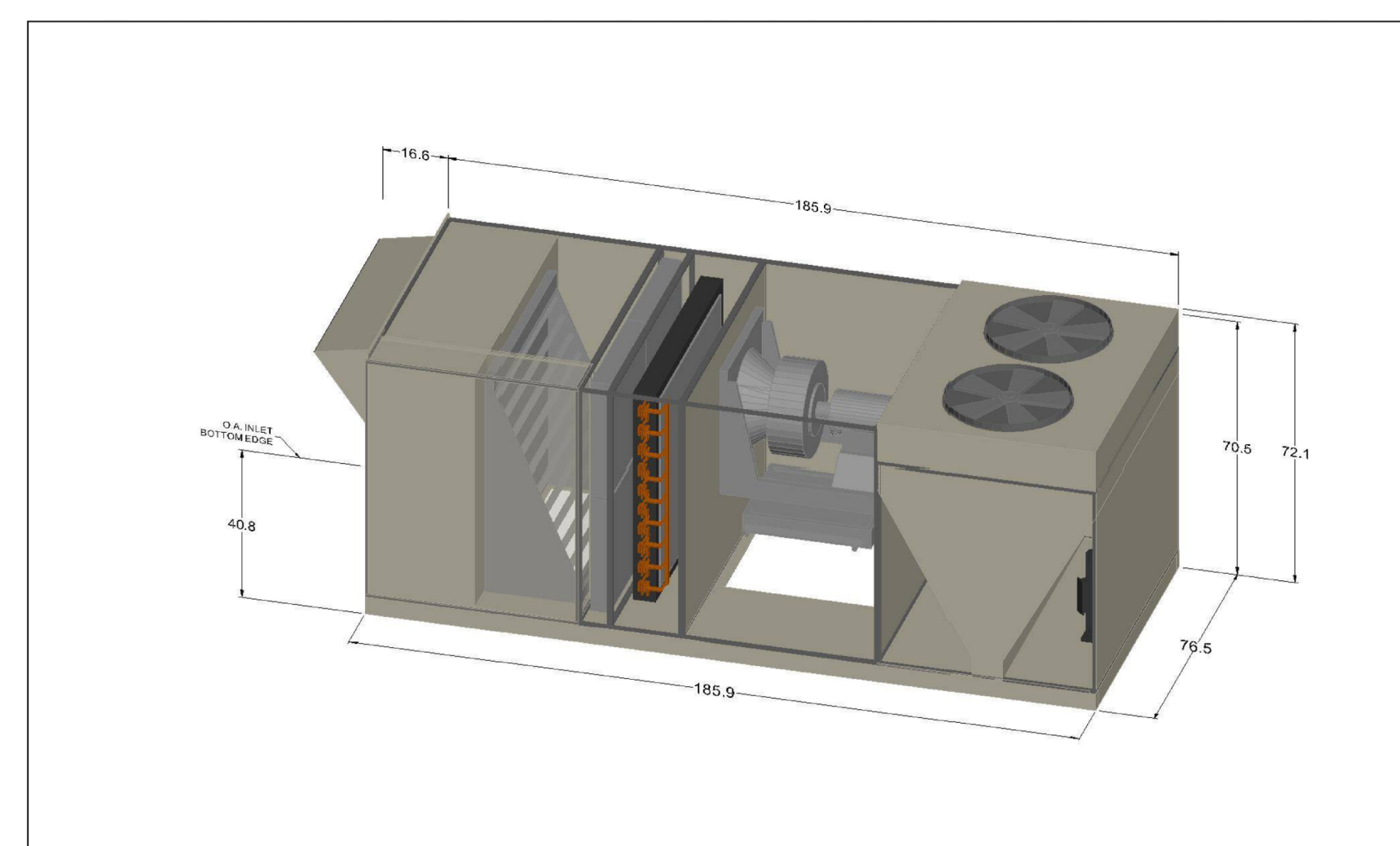
ROOF MOUNTED AIR HANDLING UNIT DETAIL

- AI GRAY SENSOR INDICATES DEVICE IS PROVIDED BY EQUIPMENT MANUFACTURER
- AI BLACK SENSOR INDICATES DEVICE IS PROVIDED BY TEMPERATURE CONTROLS CONTRACTOR



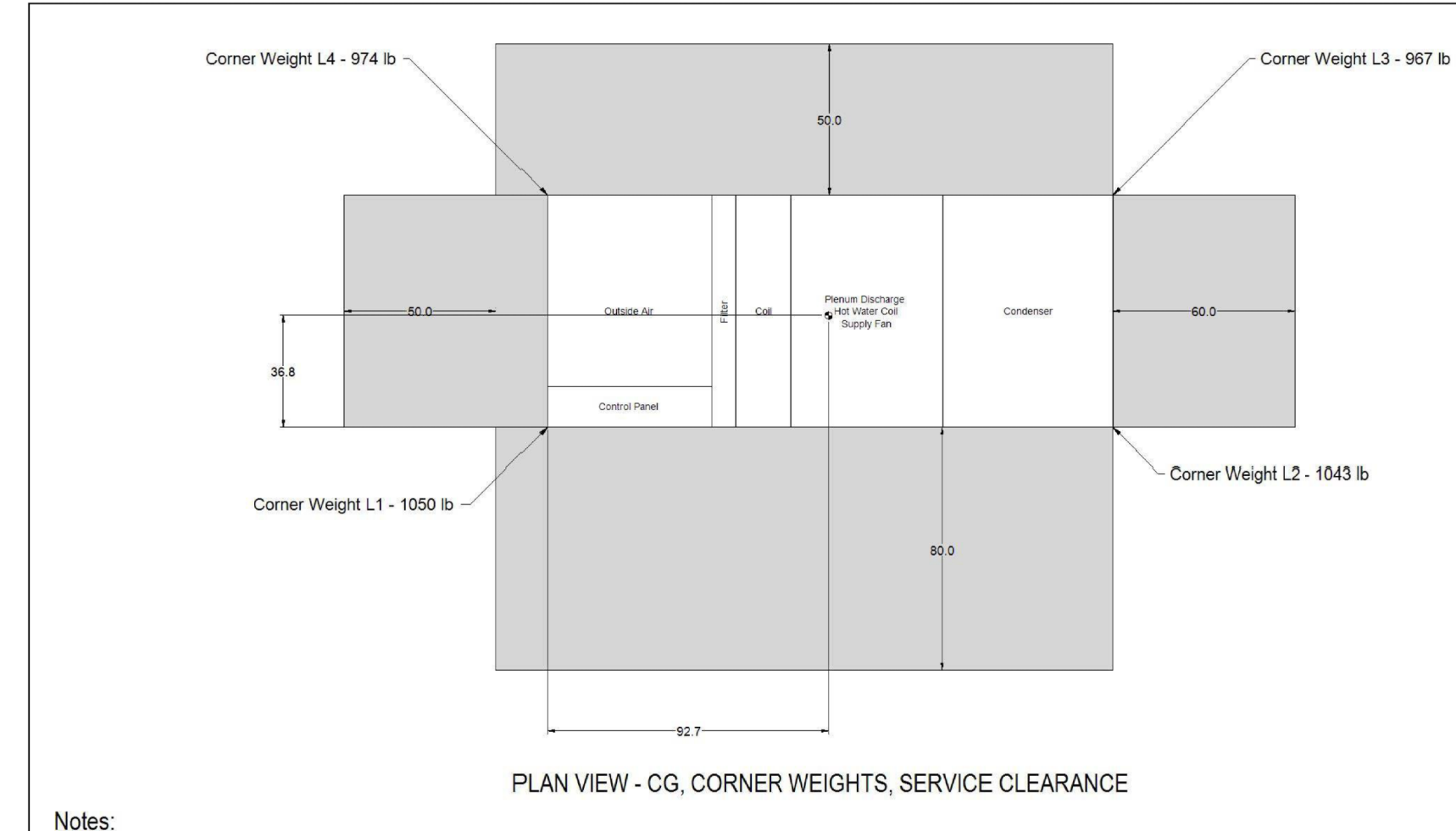
AH-6 & AH-11 SINGLE ZONE W/ RETURN FAN SEQUENCE OF OPERATION

- GENERAL: THE RTU SHALL BE PROVIDED WITH FACTORY CONTROLS. THE TCC SHALL PROVIDE AND INSTALL COMBINED THERMOSTAT HUMIDITY SENSORS AND A WET BULB SENSOR INSTALLED IN THE JOIST SPACE BY THE TCC AND WIRED TO THE BAS. SEE PLANS FOR SENSOR LOCATIONS. THE BAS WILL PROVIDE AN OUTPUT TO THE RTU CONTROLLER.
- THIS UNIT HAS THE FOLLOWING COMPONENTS:
  - POWER EXHAUST FAN (BUILDING RELIEF)
  - EXHAUST AND OUTSIDE AIR DAMPERS (ECONOMIZER MODE)
  - FILTERS
  - STAGED COMPRESSORS
  - SUPPLY FAN
  - HOT WATER HEAT
  - HUMIDITY CONTROL
- THE ROOFTOP UNIT SHALL BE PLACED INTO OPERATION BY THE DDC SYSTEM BASED UPON USER DEFINED SCHEDULE. THE FACTORY CONTROLLER WILL CHANGE FROM COOLING, FAN ONLY OR HEATING BASED ON THE HEATING AND COOLING SETPOINTS.
- SUPPLY FAN CONTROL
  - THE SUPPLY FAN WILL OPERATE CONTINUOUSLY BETWEEN A SPECIFIED MINIMUM AND MAXIMUM SPEED. THE UNIT WILL MODULATE THE SUPPLY FAN BETWEEN MINIMUM AND MAXIMUM BASED ON HOW FAR OR NEAR THE CONTROL TEMPERATURE IS AWAY FROM SETPOINT.
- POWER EXHAUST AIR FAN: THE EXHAUST FAN WILL BE CONTROLLED BY A SPACE PRESSURE SENSOR LOCATED IN THE SPACES EACH UNIT SERVES. THE EXHAUST FAN SHALL MODULATE TO MAINTAIN +0.1" W.C. PRESSURE IN THE SPACE.
- OUTSIDE AIR DAMPER CONTROL: A DUCT MOUNTED CO2 SENSOR WILL SUPPLY A PPM READING TO THE UNIT CONTROLLER. THE UNIT CONTROLLER WILL OPEN THE OA DAMPER TO PROVIDE MORE VENTILATION AIR AS REQUIRED BY THE CO2 PPM READING.
- HEATING MODE: WHEN THE SUPPLY AIR TEMPERATURE DROPS BELOW 55°F ENABLE HEAT MODE AND MODULATE THE HEATING HOT WATER VALVE AND ENABLE THE EXISTING HEATING HOT WATER UNIT PUMP TO MAINTAIN DISCHARGE AIR TEMPERATURE SETPOINT. THE MAXIMUM DISCHARGE AIR TEMPERATURE SHALL BE 90°F.
  - FREEZESTAT: IF THE CONTACTS OF THE FREEZESTAT SEND A SIGNAL TO THE CONTROLLER THE HOT WATER VALVE SHALL OPEN TO 100% FOR A 10 MINUTE PERIOD AND THEN CHECK THE FREEZESTAT STATUS. IF THE FREEZESTAT STATUS IS STILL INDICATING FREEZE PROTECTION THE TIMER SHALL RESET. THIS WILL CONTINUE UNTIL THE FREEZESTAT NO LONGER INDICATES THE COIL REQUIRES FREEZE PROTECTION.
  - HEATING DISCHARGE AIR TEMPERATURE RESET: THE HEATING DAT SETPOINT SHALL RESET BY SPACE, RETURN, OAT, NETWORK, OR EXTERNAL SIGNALS. A LINEAR RELATIONSHIP BETWEEN DAT AND THE RESET VARIABLE WILL BE CREATED FOR THE MINIMUM AND MAXIMUM DAT SETPOINTS.
- COOLING MODE: COOLING SHALL BE CONTROLLED TO MAINTAIN SUPPLY AIR TEMPERATURE SETPOINT. ON A CALL FOR COOLING, THE HEATING SHALL BE DISABLED. ON A FURTHER CALL FOR COOLING THE COMPRESSORS SHALL BE STAGED ACCORDINGLY TO MAINTAIN THE SUPPLY AIR TEMPERATURE SETPOINT.
- COMPARATIVE ENTHALPHY SHALL BE ENGAGED WHENEVER THE OUTDOOR ENTHALPHY OR DRY BULB IS LESS THAN THE RETURN AIR ENTHALPHY OR DRY BULB TO UTILIZE OUTSIDE AIR FOR COOLING. OUTSIDE AIR AND RETURN AIR DAMPERS SHALL MODULATE TO MAINTAIN SUPPLY AIR TEMPERATURE SETPOINT.
- UNOCCUPIED SUPPLY AIR TEMPERATURE HEATING: IF THE SPACE HAS A CALL FOR HEATING, THE ROOFTOP UNIT SHALL START AND SUPPLY 65°F AIR TO THE SPACE. THE OUTSIDE AIR DAMPER POSITION SHALL BE 0%.
- UNOCCUPIED SUPPLY AIR TEMPERATURE COOLING: IF THE SPACE HAS A CALL FOR COOLING, THE ROOFTOP UNIT SHALL START AND SUPPLY 55°F AIR TO THE SPACE. THE OUTSIDE AIR DAMPER POSITION SHALL BE 0%.
- BUILDING WARM UP: THE UNIT SHALL USE OPTIMAL START TO WARM THE SPACE TO SET POINT. MAXIMUM SUPPLY AIR TEMPERATURE SHALL BE 90°F. OUTSIDE AIR TO REMAIN OFF.
- BUILDING COOL DOWN: THE UNIT SHALL USE OPTIMAL START TO COOL SPACE TO SET POINT. THE OUTSIDE AIR DAMPER IS TO REMAIN CLOSED DURING THIS SEQUENCE. DURING BUILDING COOL DOWN THE LEAVING AIR TEMPERATURE FROM THE UNIT SHALL BE 55 DEG F.
- MODULATING HOT GAS REHEAT: THIS SYSTEM SHALL BE CONTROLLED BY TWO POINTS, THE LEAVING COIL TEMPERATURE SENSOR (LCT), AND A DISCHARGE AIR TEMPERATURE (DAT). DURING DEHUMIDIFICATION THE REFRIGERATION CIRCUIT ALLOWS COMPRESSORS TO MAINTAIN THE LCT SETPOINT (ADJUSTABLE). THE UNIT SHALL BE ABLE TO COOL AND DEHUMIDIFY SIMULTANEOUSLY OR JUST DEHUMIDIFY IF NO COOLING IS NEEDED. DEHUMIDIFICATION WILL BE ACTIVATED WHEN THE RELATIVE HUMIDITY IN THE RETURN SPACE RISES ABOVE THE DEHUMIDIFICATION SETPOINT.
- SMOKE DETECTOR: WHEN THE SMOKE DETECTOR IS ALARMED, THE FIRE ALARM SYSTEM SHALL BE ALARMED AND THE AHU SHALL FAIL SAFE WITH MANUAL RESET AT THE FIRE ALARM PANEL. ELECTRICAL CONTRACTOR SHALL FURNISH HVAC CONTRACTOR SHALL MOUNT & ELECTRICAL CONTRACTOR SHALL WIRE A UL LISTED PHOTOELECTRIC SMOKE DETECTOR PER LOCAL CODE AUTHORITY HAVING JURISDICTION.
- MONITORS AND ALARMS:
  - PROVIDE ALARM FOR SMOKE.
  - MONITOR THE DIFFERENTIAL PRESSURE ACROSS THE FILTERS AND PROVIDE A NOTIFICATION WHEN THE FILTERS NEED TO BE REPLACED.
  - MONITOR THE STATUS OF THE SUPPLY AND EXHAUST FAN WITH A CURRENT SWITCH. PROVIDE AN ALARM WHEN THE FANS ARE COMMANDED ON BUT A FAN IS NOT RUNNING.
- SETPOINTS (ADJ.):
  - OCCUPIED COOLING: 74 °F (ADJ.) +/- 2 °F WARMER/ COOLER ADJUST (ADJ.)
  - UNOCCUPIED COOLING: 80 °F (ADJ.)
  - OCCUPIED HEATING: 70 °F (ADJ.) +/- 2 °F WARMER/ COOLER ADJUST (ADJ.)
  - UNOCCUPIED HEATING: 60 °F (ADJ.)

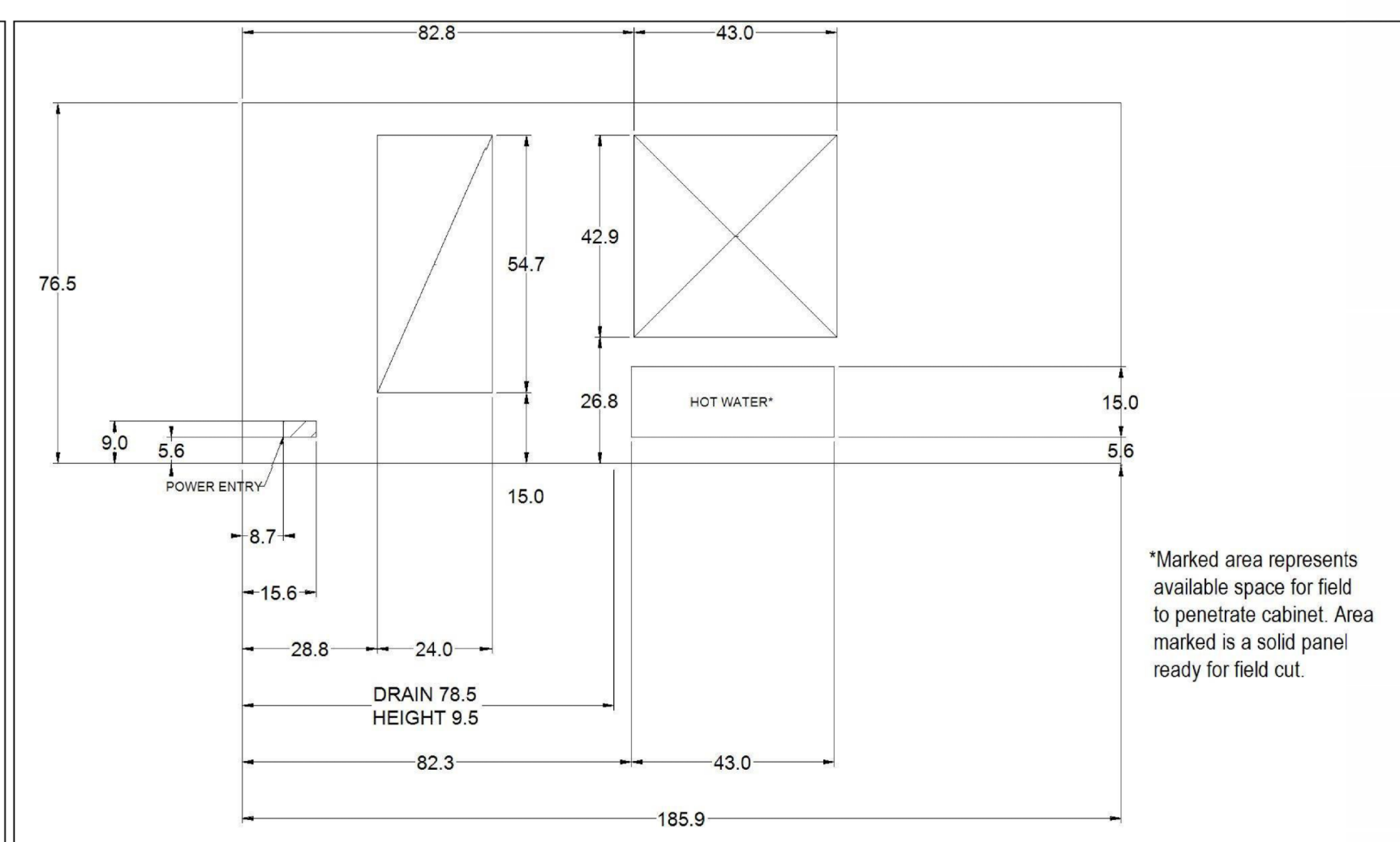


Notes:  
 (1) Recommended location for optional field cut side power connection.

Unit Tag: AH-11  
 Project Name: Loveland Middle School - AH-6 &  
 Model: DPS37  
 Sales Office: EIR/Am, Inc.  
 Sales Engineer: [Name]  
 13000 Industrial Park Blvd. Minneapolis, MN 55441  
 www.DaikinApplied.com Software Version: 12.83



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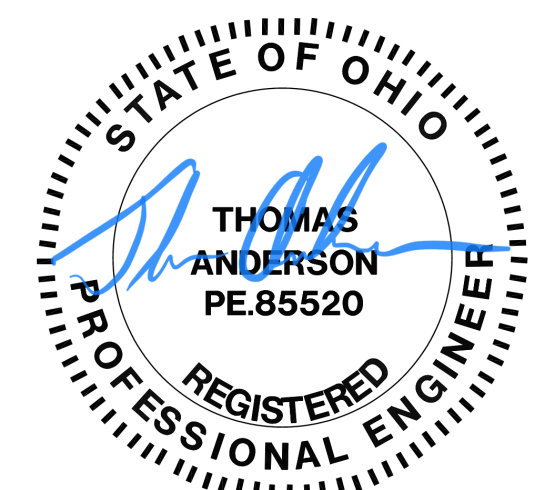


BID DOCUMENTS

LOVELAND MIDDLE SCHOOL AHU REPLACEMENT  
 LOVELAND CITY SCHOOL DISTRICT  
 801 S Lebanon Rd., Loveland, OH 45140  
 MECHANICAL DETAILS AND SCHEDULES

|                    |            |
|--------------------|------------|
| CLIENT/CMTA JOB #: | OLMS23     |
| DATE:              | 12/11/2024 |
| DRAWN:             | OTG        |
| CHECKED:           | BKR        |

REVISIONS



M-400

**TAGGED NOTES**

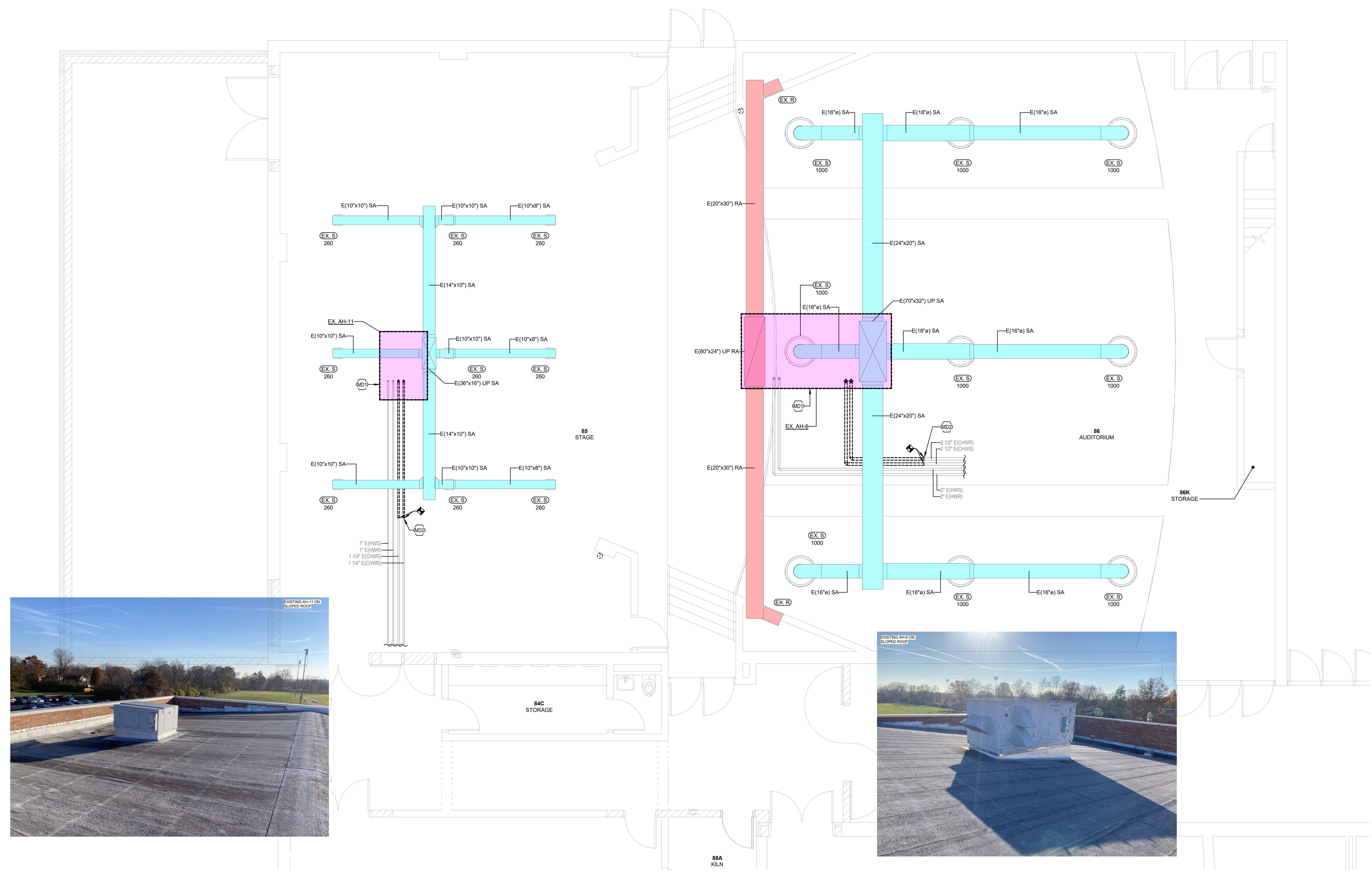
MD1 DEMOLISH EXISTING ROOFTOP AIR HANDLING UNIT IN ITS ENTIRETY, INCLUDING CONTROL WIRING.

MD2 DEMOLISH CHILLED WATER LINES TO NOT INTERFERE WITH INSTALLATION OF NEW UNIT. REINSULATE AS REQUIRED. KEEP AS MUCH OF THE EXISTING HOT WATER PIPING AS APPROPRIATE FOR CONNECTION TO THE NEW RTU.

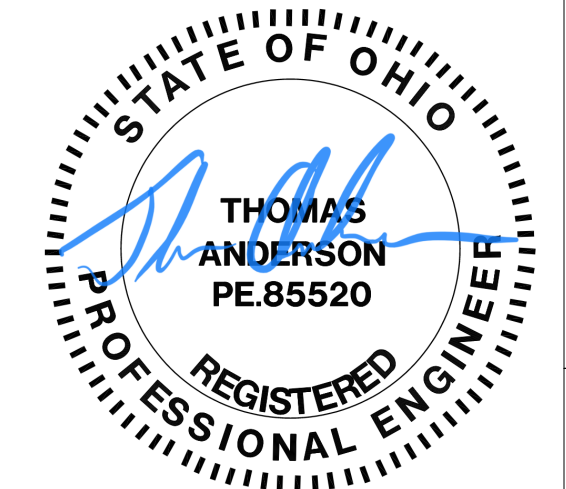


BID DOCUMENTS

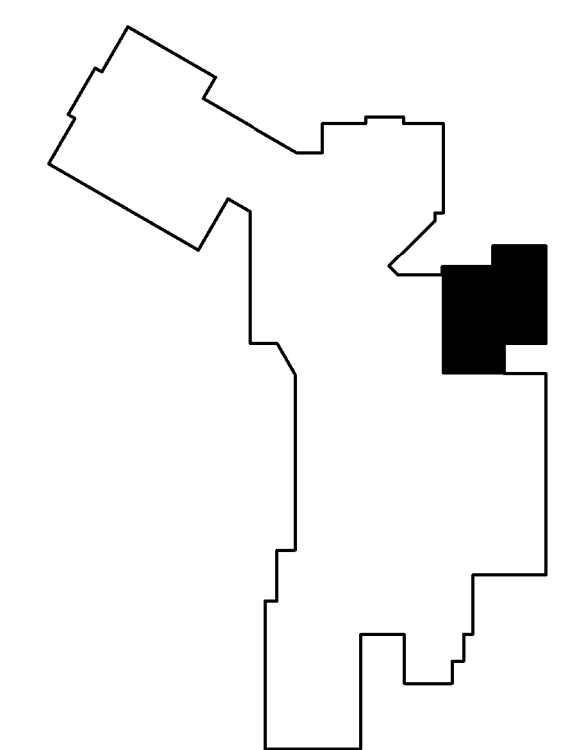
LOVELAND MIDDLE SCHOOL AHU REPLACEMENT  
 LOVELAND CITY SCHOOL DISTRICT  
 801 S Lebanon Rd., Loveland, OH 45140  
 MECHANICAL UPPER SECTION DEMOLITION PLAN



**MECHANICAL - AUDITORIUM & STAGE PLAN DEMO**  
 MD-100 1/4" = 1'-0"



KEY PLAN



|                    |            |
|--------------------|------------|
| CLIENT/CMTA JOB #: | OLMS23     |
| DATE:              | 12/11/2024 |
| DRAWN:             | OTG        |
| CHECKED:           | BKR        |

REVISIONS

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**MD-100**

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**STRUCTURAL NOTES**  
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COPIES OF PUBLICATIONS REFERENCED IN THESE GENERAL STRUCTURAL NOTES ARE AVAILABLE FOR REVIEW AT SCHAEFER. CONTRACTORS UNFAMILIAR WITH THESE PUBLICATIONS MUST REVIEW THEM PRIOR TO CONSTRUCTION.

**GOVERNING CODE**  
2024 OHIO BUILDING CODE (REFERENCES IBC 2021 & ASCE 7 16).

**DESIGN LOADS**

- 1. BAR JOIST FRAMED ROOF LOAD.
- A. MINIMUM COMBINATION OF WIND LOAD, LIVE LOAD, RAIN LOAD, OR SNOW LOAD (P, DP, L): 22 PSF
- B. DESIGN DEAD LOADS ARE UNCHANGED EXCEPT FOR THE REPLACEMENT OF TWO ROOFTOP AIR HANDLING UNITS.
- C. DESIGN WEIGHT OF NEW ROOFTOP AIR HANDLING UNITS AND CURBS ARE STATED ON PLAN.
- D. ADDITIONAL RIGGING LOADING, LMS RIGGING DRAWING JAA PROVIDED BY CMTA ON FEBRUARY 8, 2024.

\*FLAT ROOF SNOW LOAD,  $P_s = 20$  PSF  
GROUND SNOW,  $P_g = 20$  PSF  
SNOW LOAD IMPORTANCE FACTOR,  $I_s = 1.1$   
SNOW EXPOSURE FACTOR,  $C_e = 1.0$   
SNOW LOAD THERMAL FACTOR,  $C_t = 1.1$   
MINIMUM SNOW LOAD,  $P_s = 20$  PSF

COORDINATE ROOF FRAMING WITH FINAL SELECTION OF ROOF SUPPORTED MECHANICAL EQUIPMENT AND ASSOCIATED OPENINGS. ITEMS TO BE COORDINATED INCLUDE SIZE, LOCATION, TOTAL WEIGHT, WEIGHT DISTRIBUTION, AND SUPPORT FRAME REQUIREMENTS.

**CONSTRUCTION AND SAFETY**

1. ENGINEER SHALL NOT BE RESPONSIBLE FOR THE MEANS, METHODS, TECHNIQUES, SEQUENCES OR PROCEDURES OF CONSTRUCTION SELECTED BY CONTRACTOR.

2. THE CONTRACTOR WILL BE SOLELY AND COMPLETELY RESPONSIBLE FOR CONDITIONS OF THE JOB SITE INCLUDING SAFETY OF ALL PERSONS AND PROPERTY DURING PERFORMANCE OF THE WORK. THIS REQUIREMENT WILL APPLY CONTINUOUSLY AND IS NOT LIMITED TO NORMAL WORKING HOURS. WHEN ON SITE, THE ENGINEER IS RESPONSIBLE FOR HIS/HER OWN SAFETY BUT HAS NO RESPONSIBILITY FOR THE SAFETY OF OTHER PERSONNEL OR SAFETY CONDITIONS AT THE SITE.

3. CONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS AND DIMENSIONS. SHOULD ANY DISCREPANCY BE FOUND, CONTRACTOR SHALL NOTIFY ARCHITECT/ENGINEER IMMEDIATELY OF THE CONDITION.

**STRUCTURAL STEEL**

1. MATERIALS (UNLESS NOTED OTHERWISE):

- A. C AND MC SHAPES (DEPTH < 8 INCHES): ASTM A36,  $F_y = 36$  KSI
- B. L SHAPES: ASTM A572, GRADE 50,  $F_y = 50$  KSI
- C. PLATES AND BARS (THICKNESS < 4 INCHES): ASTM A572, GRADE 50,  $F_y = 50$  KSI
- D. WELDS: AWS E70XX, LOW HYDROGEN ELECTRODES.

2. ALL DETAILING, FABRICATION, AND ERECTION SHALL CONFORM TO AISC SPECIFICATIONS FOR "DESIGN, FABRICATION, AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS", AND THE AISC "CODE OF STANDARD PRACTICE FOR STEEL BUILDINGS AND BRIDGES", LATEST EDITION.

3. FABRICATOR QUALIFICATIONS: STRUCTURAL STEEL FABRICATOR SHALL PARTICIPATE IN THE AISC QUALITY CERTIFICATION PROGRAM, AND SHALL BE DESIGNATED AS AN AISC-CERTIFIED PLANT, CATEGORY STD.

4. SUBMITTALS

- A. STRUCTURAL STEEL SHOP DRAWINGS

5. CONNECTIONS:

- A. WELDING SHALL BE IN ACCORDANCE WITH THE AMERICAN WELDING SOCIETY (AWS D1.1-2010)
  - 1. HEADED STUD SHEAR CONNECTORS SHALL BE WELDED WITH AUTOMATICALLY TIMED STUD WELDING EQUIPMENT. FILLET WELDS ARE NOT PERMITTED.

6. PAINT AND PROTECTION:

- A. STEEL SURFACES TO BE PAINTED (COORDINATE LOCATIONS WITH ARCHITECT); PREPARE SURFACES PER SSPC-SP1 "POWER TOOL CLEANING" AND PAINT WITH FABRICATOR'S STANDARD PRIME COAT (BLACK). IMMEDIATELY AFTER ERECTION, CLEAN EXPOSED AREAS WHERE PRIMER IS DAMAGED OR MISSING. PREPARE SURFACES BY SSPC-SP2 OR SSPC-SP3, AND PAINT WITH MATCHING SHOP PRIME COAT (BLACK).

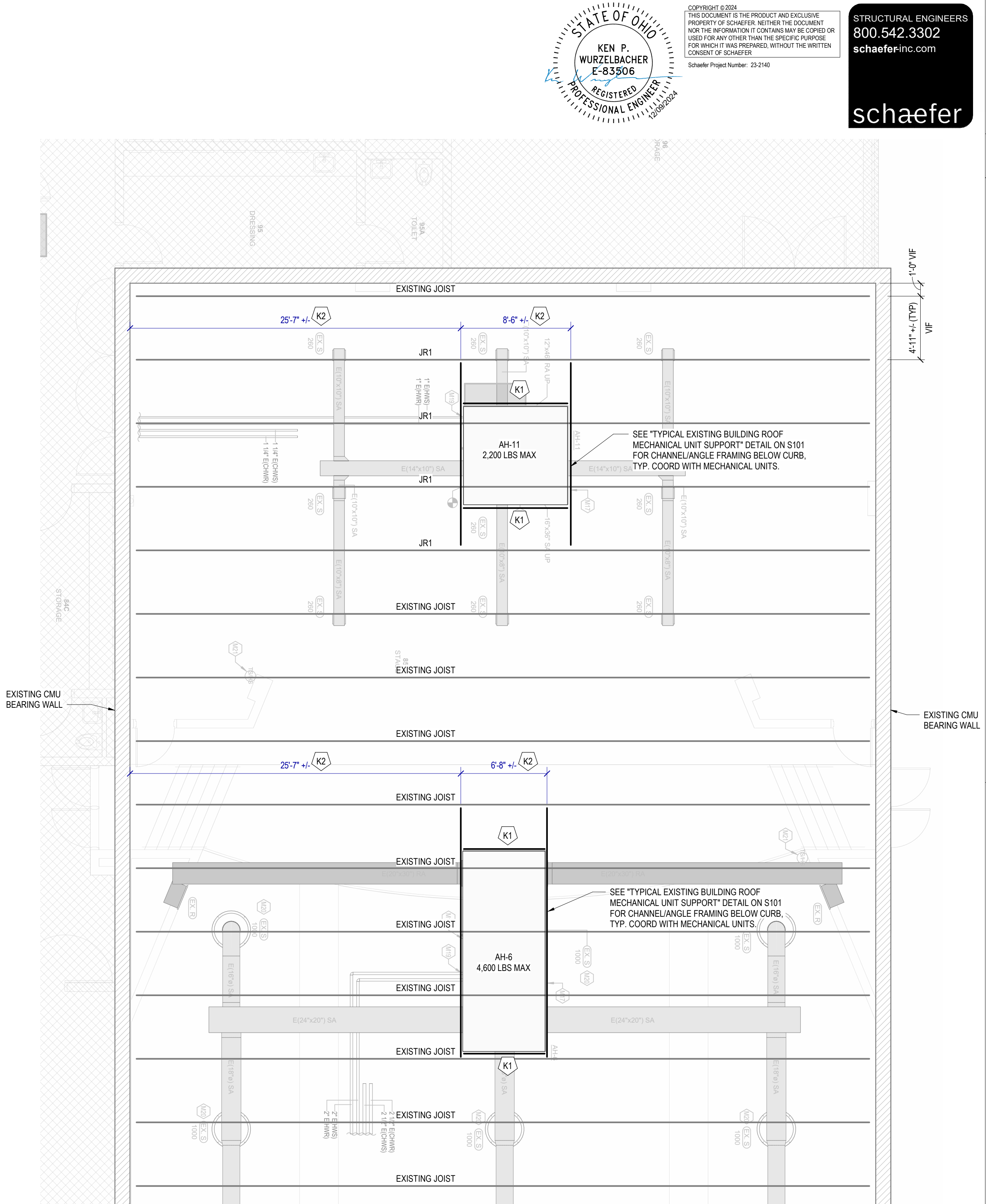
**SPECIAL INSPECTIONS**

1. SPECIAL INSPECTIONS ARE REQUIRED BY SECTION 1704 OF THE REFERENCED BUILDING CODE. THE INTENT OF SPECIAL INSPECTIONS IS TO VERIFY THE COMPLIANCE OF MATERIALS, INSTALLATION, FABRICATION, ERECTION OR PLACEMENT OF COMPONENTS WITH THE COMPLETED SET OF CONSTRUCTION DOCUMENTS AND REFERENCED STANDARDS. IT IS THE RESPONSIBILITY OF ALL PARTIES INVOLVED TO BECOME FAMILIAR WITH THE SPECIAL INSPECTION REQUIREMENTS SET FORTH IN CHAPTER 17 OF THE REFERENCED BUILDING CODE. SPECIAL INSPECTIONS SHALL BE PROVIDED BY THE OWNER OR THE OWNER'S AGENT AND SHALL NOT BE CONSIDERED IN THE SCOPE OF WORK OF THE CONTRACTOR.

2. THE SCHEDULE OF SPECIAL INSPECTIONS FOR STRUCTURAL WORK HAS BEEN PREPARED IN ACCORDANCE WITH SECTIONS 106.1 AND 1704 OF THE REFERENCED BUILDING CODE AND IS AVAILABLE UPON REQUEST. SEE OTHERS FOR SPECIAL INSPECTION REQUIREMENTS FOR NON-STRUCTURAL WORK. THE SPECIAL INSPECTOR(S) SHALL COORDINATE WITH THE OWNER, CONTRACTORS, AND DESIGN PROFESSIONALS AND SCHEDULE ALL INSPECTIONS ACCORDINGLY.

| SCHEDULE OF SPECIAL INSPECTION SERVICES - 1705.2.1 STRUCTURAL STEEL |  |         |         |     |   |          |
|---|--|---------|---------|-----|---|----------|
| Item  | Sub Item / Scope   | Extent  |         |     | Agency Qualifications                               | Comments |
|   |  | Observe | Perform | N/A |   |          |
| 2. Material verification of structural steel                        | Verify material in shop and field inspection   |         | X       |     | Testing Agency                                      |          |
| 4. Verify compliance with construction documents                    | Verify member locations, bracing, stiffeners, and application of joint details at each connection comply with construction documents.  |         | X       |     | Testing Agency                                      |          |
| 5.4-1. Visual Welding Inspection - Inspection Tasks Before Welding: | 1. Welder qualifications records and continuity records.   |         | X       |     | Testing Agency<br>AWS - Certified Welding Inspector |          |
|   | 2. Welding procedure specifications (WPS) available.   |         | X       |     |   |          |
|   | 3. Manufacturer certifications for welding consumables available.  |         | X       |     |   |          |
|   | 4. Material identification (type/grade).   |         | X       |     |   |          |
|   | 5. Welder identification system (The fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low stress type).   |         | X       |     |   |          |
|   | 6. Fit up of Groove Welds (including Joint Geometry): Inspection shall include Joint preparation, Dimensions (alignment, root opening, roof face, and bevel), Cleanliness (condition of steel surfaces), Tacking (back weld quality and location), Backing type and fit (if applicable).                                     |         | X       |     |   |          |
|   | 7. Fit up of CJP Groove Welds of HSS T-, K-, Y-, and X-joints (including Joint Geometry): Inspection shall include joint preparation, Dimensions (alignment, root opening, roof face, and bevel), Cleanliness (condition of steel surfaces), Tacking (back weld quality and location), Backing type and fit (if applicable). |         | X       |     |   |          |
| 5.4-2. Visual Welding Inspection - Inspection Tasks During Welding: | 1. Configuration and finish of access holes.   |         | X       |     | Testing Agency<br>AWS - Certified Welding Inspector |          |
|   | 2. Control and Handling of Welding Consumables: Packaging and Exposure control.  |         | X       |     |   |          |
|   | 3. No welding over cracked tack welds.   |         | X       |     |   |          |
|   | 4. Environmental Conditions: Wind speed within limits, and Precipitation and temperature.  |         | X       |     |   |          |
|   | 5. WPS Followed: Observe Settings on welding equipment, Travel speed, Selected welding materials, Shielding gas type/flow rate, Preheat applied, Filletpass temperature maintained (min and max), and Proper position (P, V, CH).  |         | X       |     |   |          |
|   | 6. Welding Techniques: Interpass and final clearing. Each pass with profile limitations, Each pass meets quality requirements.   |         | X       |     |   |          |
|   | 7. Placement and installation of steel headed stud anchors.  |         | X       |     |   |          |
|   | 8. Repair Activities: Document acceptance or rejection of welded joint or member.  |         | X       |     |   |          |
|   | 9. No prohibited welds have been added without the approval of the EOR.  |         | X       |     |   |          |
|   | 10. Check welding equipment.   |         | X       |     |   |          |
| 5.4-3. Visual Welding Inspection - Inspection Tasks After Welding:  | 1. Welds Cleaned:  |         | X       |     | Testing Agency<br>AWS - Certified Welding Inspector |          |
|   | 2. Size, Length, and Location of Welds:  |         | X       |     |   |          |
|   | 3. Welds meet visual acceptance criteria: Crack prohibition, Weld/base-metal fusion, Crater cross section, Weld profiles, Weld size, Undercut, Porosity.   |         | X       |     |   |          |
|   | 4. Arc strikes:  |         | X       |     |   |          |
|   | 5. K-area:   |         | X       |     |   |          |
|   | 6. Weld access holes in rolled heavy shapes and built-up heavy shapes:   |         | X       |     |   |          |
|   | 7. Backing Removed and weld tabs removal (if required):  |         | X       |     |   |          |

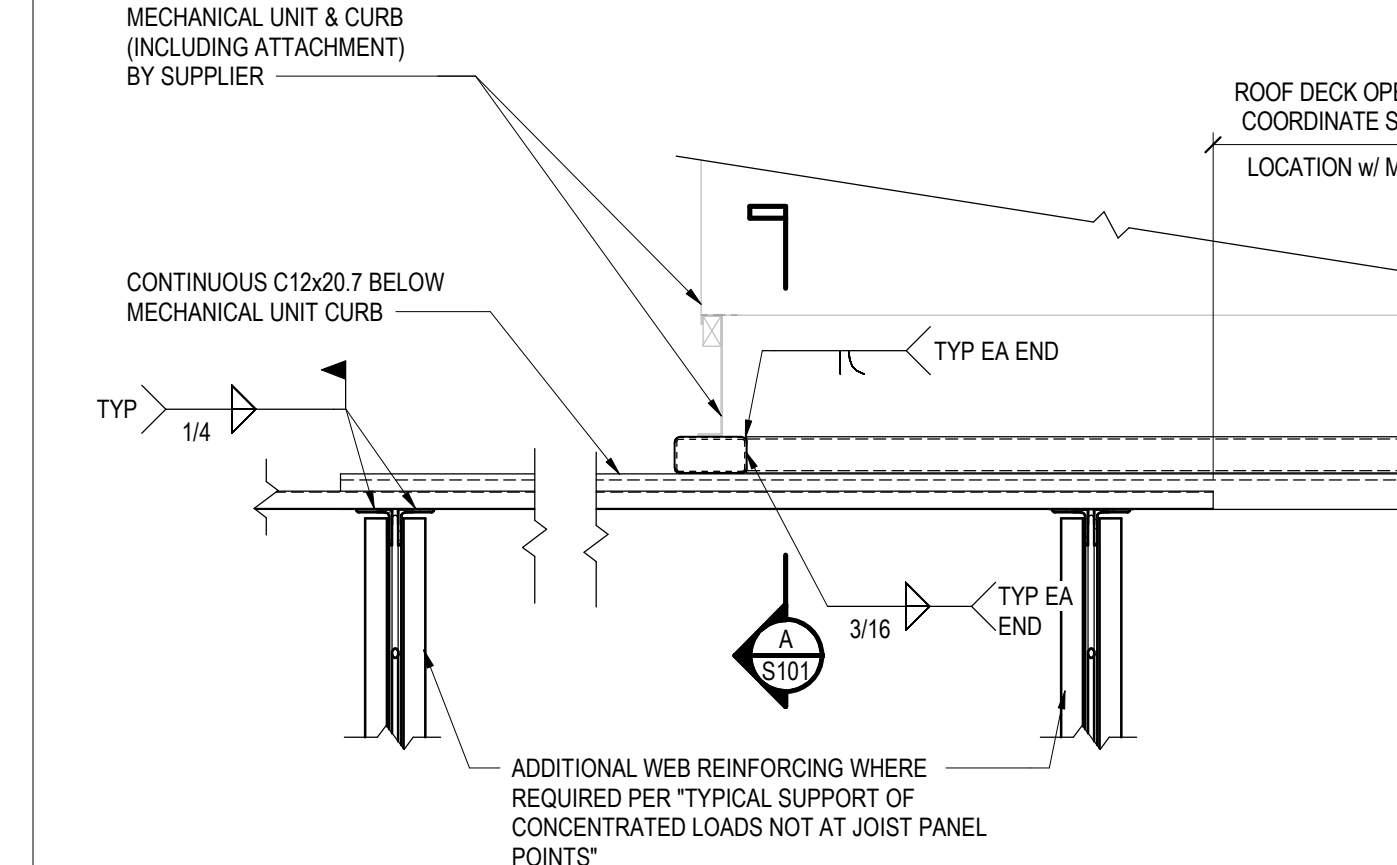
| ABBREVIATIONS |                                  |
|---------------|----------------------------------|
| AFF           | = ABOVE FINISHED FLOOR ELEVATION |
| ARCH          | = ARCHITECT                      |
| BF            | = BOTTOM OF                      |
| BLDG          | = BUILDING                       |
| BOT           | = BOTTOM                         |
| BRG           | = BEARING                        |
| CJP           | = COMPLETE PENETRATION JOINT     |
| CL            | = CENTER LINE                    |
| CLR           | = CLEAR                          |
| CMU           | = CONCRETE MASONRY UNIT          |
| DEG or °      | = DEGREE                         |
| DIA or Ø      | = DIAMETER                       |
| EA            | = EACH                           |
| EL            | = ELEVATION                      |
| EQ            | = EQUAL                          |
| EXIST         | = EXISTING                       |
| LDH           | = LONG DIMENSION HORIZONTAL      |
| MFR           | = MANUFACTURER                   |
| OC            | = ON CENTER                      |
| OPENG         | = OPENING                        |
| PL            | = PLATE                          |
| SM            | = SIMILAR                        |
| SPA           | = SPACE or SPACES                |
| TS            | = TOP OF                         |
| UNO           | = UNLESS NOTED OTHERWISE         |
| VF            | = VERIFY IN FIELD                |
| W             | = WITH                           |
| WP            | = WORK POINT                     |



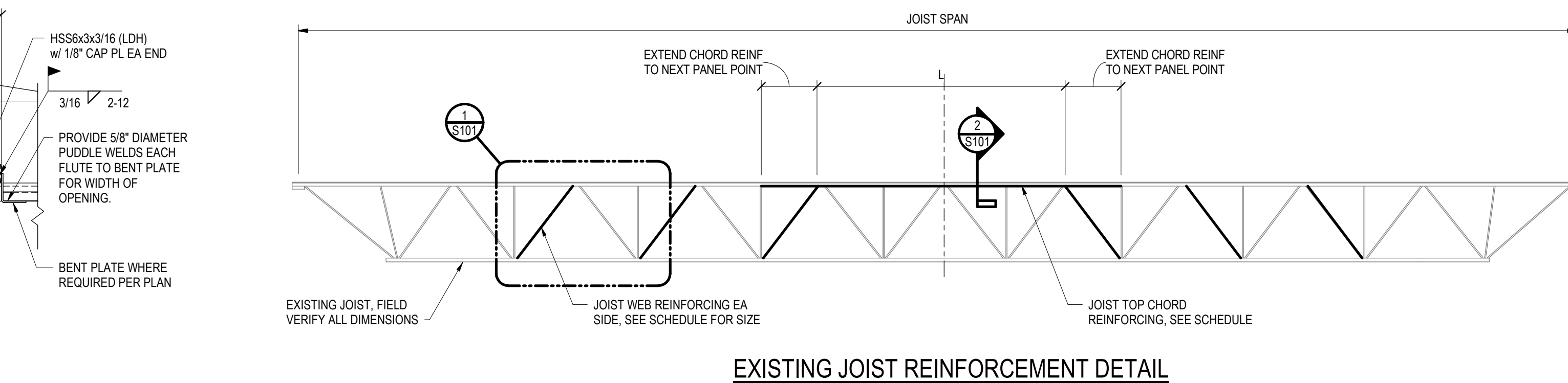
**ROOF FRAMING PLAN**  
3/16" = 1'-0"

- ROOF FRAMING PLAN NOTES:**
- ALL RELEVANT CONDITIONS/DIMENSIONS SHALL BE FIELD VERIFIED PRIOR TO THE START OF CONSTRUCTION AND FABRICATION OF STRUCTURAL STEEL.
  - MECHANICAL UNITS AND WEIGHTS ARE SHOWN FOR DESIGN PURPOSES. COORDINATE FINAL LOCATION AND WEIGHT WITH MEP DRAWINGS AND CONTRACTOR. SHOULD ANY DISCREPANCY BE FOUND, CONTRACTOR SHALL NOTIFY ARCHITECT / ENGINEER IMMEDIATELY OF THE CONDITION. COORDINATED FRAMING LOCATIONS SHALL BE SUBMITTED ON THE STRUCTURAL STEEL SHOP DRAWINGS.
  - SEE SHEET S101 FOR ABBREVIATIONS & LEGEND (SYMBOLS).
  - SEE SHEET S101 FOR JOIST REINFORCEMENT SCHEDULE.
  - DO NOT DAMAGE EXISTING STEEL FRAMING TO REMAIN DURING REMOVAL OF EXISTING UNITS WHERE THEY OCCUR.

- KEYNOTES**
- K1 AT DECK OPENINGS ADJACENT TO HSS BEAM, PROVIDE BENT PLATE CONNECTION TO DECK IN TYPICAL EXISTING ROOF MECHANICAL UNIT SUPPORT DETAIL ON S101. COORDINATE OPENING LOCATIONS WITH MEP DRAWINGS AND CONTRACTOR.
  - K2 FINAL LOCATION OF UNIT TO BE COORDINATED WITH CMTA AND FIELD VERIFIED DIMENSIONS.

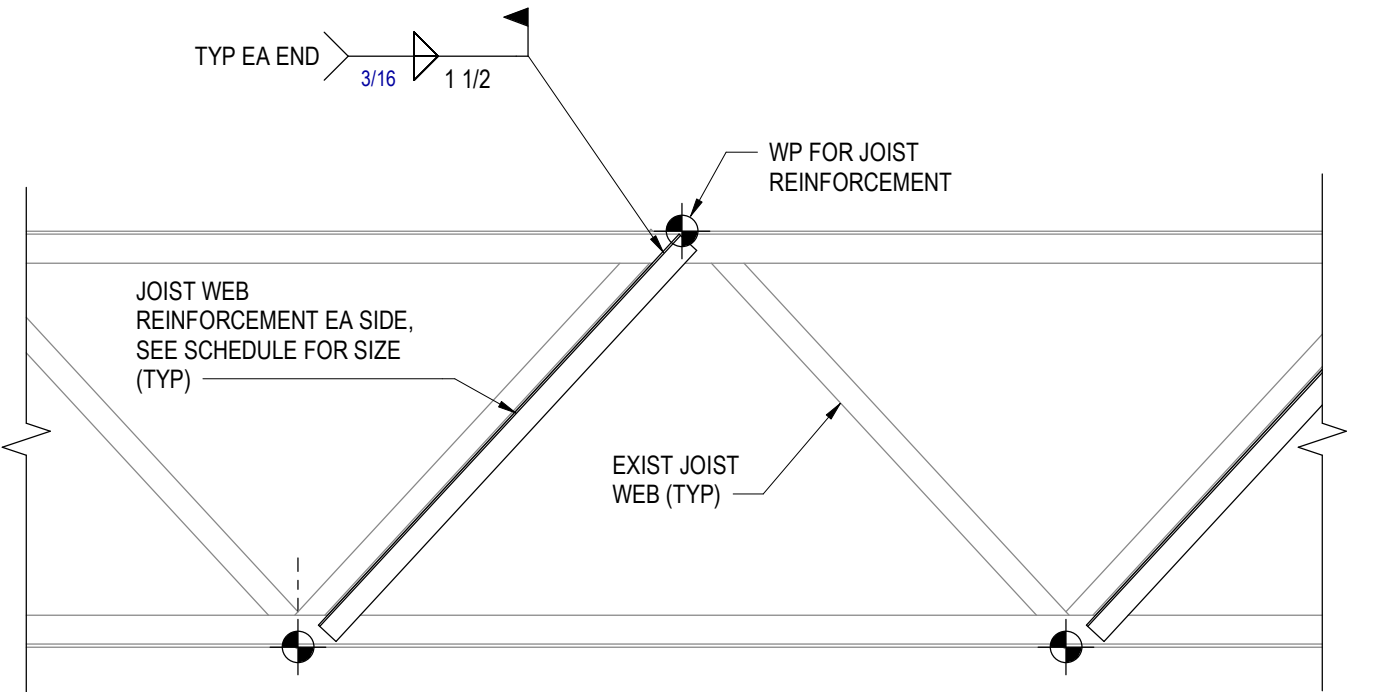


**TYPICAL EXISTING BUILDING ROOF MECHANICAL UNIT SUPPORT**  
NTS

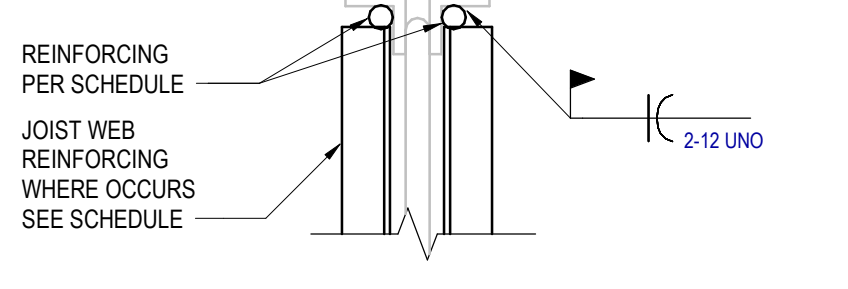


**EXISTING JOIST REINFORCEMENT DETAIL**  
NTS

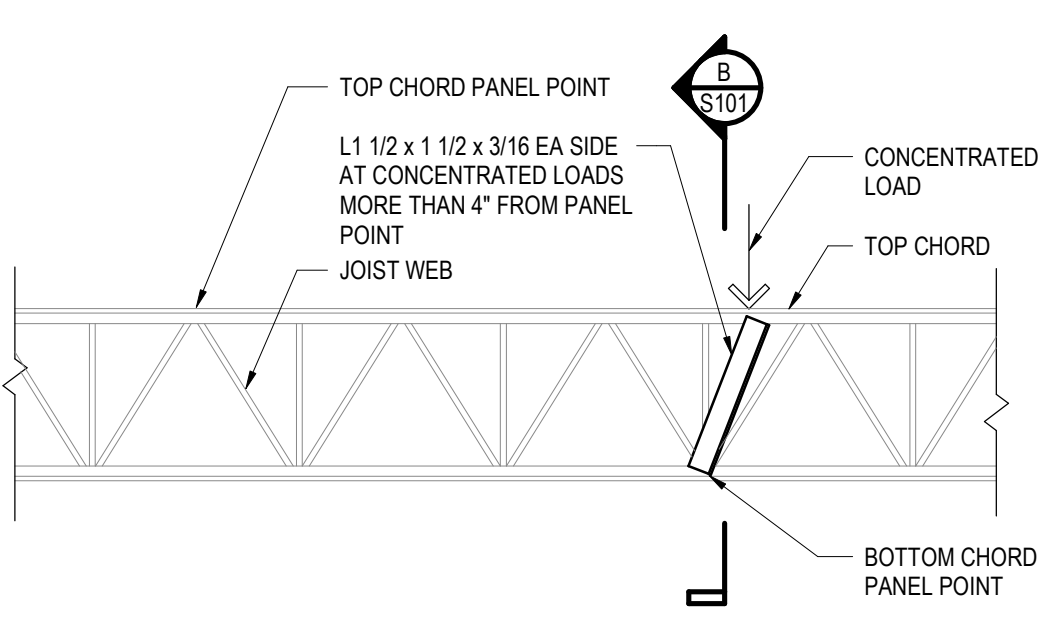
| JOIST REINFORCEMENT SCHEDULE    |  |  |                              |
|---------------------------------|--|--|------------------------------|
| JOIST REINFORCEMENT DESIGNATION | TOP & BOT CHORD ROD REINFORCEMENT (SECTION 1/S311) | WEB REINFORCEMENT w/ DOUBLE ANGLE (SECTION 1/S311) | CHORD REINFORCEMENT LENGTH L |
| JR1                             | (1) 1/2" Ø ROD                                     | (2) L1-1/2x1-1/2x3/16                              | 11'-0"                       |



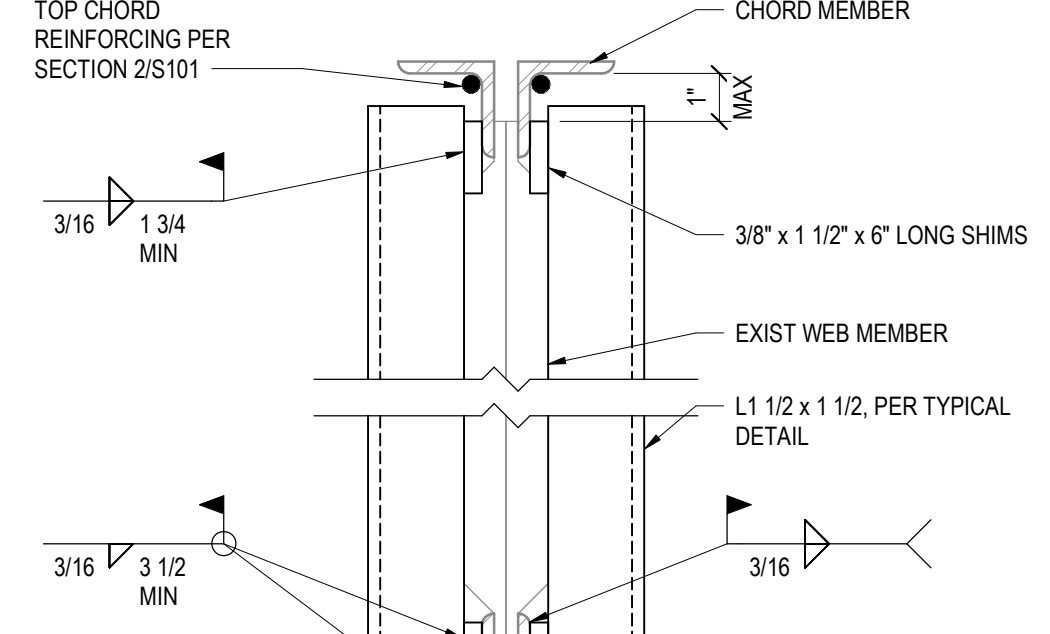
**DETAIL 1**  
NTS S101



**CHORD REINFORCING DETAIL 2**  
NTS S101



**TYPICAL SUPPORT OF CONCENTRATED LOADS NOT AT JOIST PANEL POINTS**  
NTS



**SECTION B**  
3" = 1'-0" S101

**NOTE:** COORDINATE ROOF FRAMING WITH FINAL SELECTION OF ROOF SUPPORTED MECHANICAL EQUIPMENT AND ASSOCIATED OPENINGS. ITEMS TO BE COORDINATED INCLUDE SIZE, LOCATION, TOTAL WEIGHT, WEIGHT DISTRIBUTION, AND SUPPORT FRAME REQUIREMENTS.

STATE OF OHIO  
KEN P. WURZELBACHER  
E-83506  
REGISTERED PROFESSIONAL ENGINEER  
SCHEDULE NUMBER: 23-2140

STRUCTURAL ENGINEERS  
800.542.3302  
schaeferinc.com

**schaefer**

**CMTA**

**Loveland**  
CITY SCHOOL DISTRICT

BID DOCUMENTS

**LOVELAND MIDDLE SCHOOL AHU REPLACEMENT**  
**LOVELAND CITY SCHOOL DISTRICT**  
801 S Lebanon Rd, Loveland, Ohio 45140

**ROOF FRAMING PLAN**

|                    |            |
|--------------------|------------|
| CLIENT/CMTA JOB #: | OLMS23     |
| DATE:              | 12/11/2024 |
| DRAWN:             | RGB        |
| CHECKED:           | KPW        |

**REVISIONS**

| NO. | DESCRIPTION |
|-----|-------------|
|     |             |
|     |             |
|     |             |

**S101**

## SECTION 23051 - COMMON REQUIREMENTS FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUBMITTAL REQUIREMENTS

##### A. Shop Drawings

1. Coordination Drawings: This contractor shall provide necessary coordination drawings required to make sure all disciplines are coordinated and fit into specified spaces (i.e. ceilings, chases, and all others). It is the work of the contractor to prepare complete coordination drawings indicating exact location, clearances and penetrations of all items of all trades.

#### 1.2 RELATED DOCUMENTS

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

#### 1.3 GENERAL DIRECTION

- A. Submittal of a bid indicates that the contractor has examined the drawings, specifications, and had an opportunity to visit the site to be able to provide a comprehensive complete bid.
  - B. The intent of these specifications and the accompanying drawings is to provide complete and workable systems as shown, specified and required by applicable codes. Interpret these specifications in conjunction with the drawings and provide all work described. If work is shown on drawings and not mentioned in the specifications, or vice versa, it is to be included in the work the same as though clearly set forth by both. Should there be a conflict between the specifications and drawings, provide the greater quantity or better quality. Immediately notify owner's representative and design professional of such conflicts.
  - C. The drawings that accompany these specifications are diagrammatic and although size and location of equipment is drawn to scale wherever possible make use of submittal data and verify all dimensions on site. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Follow the drawings as closely as is practical and install additional bends, offsets and elbows where required by site conditions and codes at no additional cost. Install all new work in such manner as to conform to the structure, avoid obstructions, provide required service clearances and preserve headroom. Do not scale from drawings, all measurements should be taken in the field.
- A. Coordinate all work with all other contractors and installers in addition to existing building obstructions and install accordingly. Comply with requirements of architectural drawings including but not limited to mounting height and locations. Fully research peculiarities and limitations of space available for installation of work with materials being provided. Work around material lead times to not extend project schedule.

- B. Complete work, or part(s) thereof, at times as may be designated by the Owner's Representative, so that it can be used for temporary or permanent use. Do not construe such use of the system as an acceptance of it by Owner.
- C. During mobilization or construction, if an abnormal condition is uncovered either with existing conditions, equipment loads, submittal data, etc. bring these to the attention of the Design Professional for review.
- D. Owner's Representative or Design Professional may relocate devices prior to installation within a 20-foot limit at no additional charge.
- E. All ducts shall be run as straight as possible and symmetrical with architectural items. Ductwork fabricated before coordination with the other trades will be done at the contractor's risk.
- F. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of Bidder/Proposer's own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation from the Owner.
- G. Each Bidder/Proposer shall also be governed by any unit prices and Addenda insofar as they may affect part of their work or services.

#### 1.4 GENERAL STANDARDS

- A. Provide materials, installation methods, workmanship, testing, etc., in strict accordance with the latest edition of applicable standards and adopted codes, including (but not limited to) the following.
  - 1. State Building Code and applicable local amendments.
  - 2. Local Building Code (if applicable)
  - 3. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
  - 4. American Society of Test Materials (ASTM)
  - 5. National Fire Protection Association (NFPA)
  - 6. Underwriters Laboratories (UL)
  - 7. National Sanitation Foundation (NSF)
  - 8. Sheet Metal & Air Conditioning Contractors National Association (SMACNA)
  - 9. American National Standards Institute (ANSI)
  - 10. Building Code Seismic Relative Displacement Requirements

#### 1.5 PERMITS AND REGULATIONS

- A. Obtain and pay for permits, fees, certificates of inspection and approval, etc. required for this branch of the work. Furnish Owner with certificates of final inspection and approval prior to final acceptance of this branch of the work.
- B. Laws and regulations which bear upon or affect the various branches of this work shall be complied with by this contractor and are hereby made a part of this contract.

## 1.6 DEFINITIONS

- A. Contractor - Any Contractor whether bidding, proposing or working independently or under the supervision of a General Contractor, Prime Contractor, Construction Manager and who installs any type of Mechanical Work as specified in the Contract Documents or, the General Contractor.
- B. Engineer - The Consulting Mechanical-Electrical Engineer either consulting to the Owner, Architect, or Other, etc. In this case: CMTA, Inc., Consulting Engineers.
- C. Architect - The Architect of Record for the project.
- D. Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Contract with Owner, etc.
- E. Bidder/Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.
- F. The Project - All of the work required under this Contract.
- G. Furnish - Procure, supply and deliver to project site, ready for installation, install and warrant (unless indicated otherwise on documents). Include warranty expenses.
- H. Install - To supply labor, tools and incidental materials necessary to handle, store, mount, terminate, program, configure and adjust a product in order render the respective product and system fully operational and usable to the Owner for the intended purpose.
- I. Provide - Furnish and Install. Similar Terms: "include", "shall", "equip with", "consisting of".
- J. Equal or Equivalent - Determination of equivalency to be made by design professional for all products not listed as basis-of-design.
- K. Indicated - Listed in the Specifications, shown on the Plans or Addenda thereto.
- L. Typical or Typ.- Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.
- M. Substantial Completion - Where frontend documentation does not define, products and systems must be fully installed as designed, tested, adjusted, labeled, and functionally demonstrated to owner.

## 1.7 REQUESTS FOR INFORMATION

- A. Submit all questions, requests for information (RFIs) and similar queries through the formally-established RFI process for the project that has been accepted by the Owner's Representative, Design Professionals, Prime Contractor and subcontractors. Submit as a PDF file. Do not submit as text in an email.

1.8 AVAILABILITY OF ELECTRONIC DRAWINGS

- A. If expressly permitted by the Owner and the terms of the Contract, editable electronic drawings may be made available for the creation of shop and as-built drawings upon request. Drawings will be made available at the discretion of the Engineer.
- B. "Drawing Release" form can be obtained from the CMTA project manager upon request.

1.9 QUALITY ASSURANCE

- A. Contractor shall have a minimum five (5) years' experience in the installation of systems similar to the systems specified. Contractor, if requested, shall demonstrate his ability to perform all work to be included under the contract. Assurance if requested, shall be in the form of a list of past projects of similar size and complexity and a list of six (6) references pertaining to those projects. Failure to demonstrate these quality assurances shall be taken as a statement of the contractor's inability to perform.

1.10 INTENT AND INTERPRETATION

- A. It is the intention of the Contract Documents to call for a complete and operational system, including all components, accessories, finish work, etc as necessary for trouble free operation; tested and ready for operation. Anything that may be required, implied, or inferred by the Contract Documents shall be provided and included as part of the Bid.
- B. All Contractors and Vendors providing a bid for this project shall review the Plans and Specifications and determine any modifications and/or adjustments necessary relative to the proposed equipment and materials with specific manufacturer's installation requirements. Include in the bid any necessary installation methods, features, options, accessories, etc. necessary to install the proposed equipment and materials, regardless of whether used as basis of design or being offered as a substitution in accordance with the specific manufacturer's installation requirements whether specifically detailed or not within the Plans and Specifications.
- C. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.
- D. The Bidder/Proposer shall completely review the Contract Documents. Any interpretation as to design intent or scope shall be provided by the Engineer / Architect. Should an interpretation be required, the Bidder/Proposer shall request a clarification not less than ten (10) days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event of any conflict, discrepancy, or inconsistency develops; the interpretation of the Engineer shall be final.
- E. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten (10) days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in the bid, and that will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

1.11 CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.:

- A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, taps, tap fees, extensions, etc. in connection with their work. They shall also file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments and/or the appropriate municipality or utility company having jurisdiction, whether indicated or specified or not. They shall also obtain all required certificates of inspection for their work and deliver same to the Engineer before request for acceptance and final payment for the work.
- B. Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.
- C. The Contractor shall include in their work, without extra cost, any labor, materials, services, apparatus and Plans in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.
- D. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.
- E. All materials and equipment so indicated and all equipment and materials for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable.
- F. All plumbing work is to be constructed and installed in accordance with applicable codes, Plans and Specifications which have been approved in their entirety and/or reflect any changes requested by the Authority Having Jurisdiction. Plumbing work shall not commence until such Plans are in the possession of the Plumbing Contractor.
- G. All Heating, Ventilation and Air Conditioning work shall be accomplished in accordance with the Building Code and amendments thereto, the latest standards recognized by the American Society of Heating, Refrigerating and Air Conditioning and the National Fire Protection Association.
- H. The Contractor shall furnish three (3) copies of all Final Inspection Certificates obtained to the Engineer when work is complete. Final payment for work will be contingent upon compliance with this requirement.
- I. Where minimum code requirements are exceeded in the Design, the Design shall govern.
- J. The Contractor shall ensure that their work is accomplished in accord with the OSHA Standards and that they conduct their work and the work of their personnel in accord with same.
- K. All work relating to the handicapped shall be in accord with regulations currently enforced by the
- L. Discharge of any toxic, odorous or otherwise noxious materials into the atmosphere or any system shall be subject to regulations of the Environmental Protection Agency (EPA) and/or the air pollution control commission. If in doubt, contact the State Department for Environmental Protection.

- M. Where conflict arises between any code and the Plans and/or Specifications, the code shall apply except in the instance where the Plans and Specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten (10) days prior to bid date, otherwise the Contractor shall make the required changes at their own expense.

1.12 PLANS AND SPECIFICATIONS:

- A. The Plans are diagrammatic only and indicate the general arrangement of the systems and are to be followed. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The Plans are not intended to show every item which may be necessary to complete the systems. All Bidder/Proposers shall anticipate that additional items may be required and submit their Bid accordingly.
- B. The Plans and Specifications are intended to supplement each other. No Bidder/Proposer shall take advantage of conflict between them, or between parts of either. Should this condition exist, the Bidder/Proposer shall request a clarification not less than ten (10) days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be final.
- C. The Plans and Specifications shall be considered to be cooperative and anything appearing in the Specifications which may not be indicated on the Plans or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.
- D. Contractor shall make all of their own measurements in the field and shall be responsible for correct fitting. The work shall be coordinated with all other branches of work in such a manner as to cause a minimum of conflict or delay.
- E. The Engineer shall reserve the right to make adjustments in location of piping, ductwork, equipment, etc. where such adjustments are in the interest of improving the project.
- F. Should conflict, overlap or duplication of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume to be relieved of the work which is specified under their branch until instructions in writing are received from the Engineer.
- G. Unless dimensioned, the Plans only indicate approximate locations of equipment, piping, ductwork, etc. Dimensions given in figures on the Plans shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to insure no conflict with other work.
- H. Each Bidder/Proposer shall review all Plans in the Contract Documents to ensure that the work they intend to provide does not create a conflict with or affect the work of others in any way. Where such effect does occur, it shall be the Bidder/Proposer's responsibility to satisfactorily eliminate any such conflict or effect prior to the submission of their proposal. Each Bidder/Proposer shall in particular ensure that there is adequate space to install their equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the Bidder/Proposer and shall be accomplished fully without expense to others and that they are

reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to insure adequate spaces.

- I. Where on the Plans a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.
- J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.
- K. Where within the Contract Documents the word "typical" or "typ." is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.
- L. Each Contractor shall evaluate ceiling heights specified on Architectural Plans. Where the location of equipment or systems may interfere with ceiling heights or maintenance and access of equipment or systems, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Do not install equipment or systems in the affected area until the conflict is resolved. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work or cost incurred on the part of the Contractor or unduly delay the work.

#### 1.13 COOPERATION AND COORDINATION WITH OTHER TRADES:

- A. The Contractor shall give full cooperation to all other trades and shall furnish in writing with copies to the Engineer, any information necessary to permit the work of other trades to be installed satisfactorily and with the least possible interference or delay.
- B. Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than  $\frac{1}{4}'' = 1'-0''$ , clearly indicating how their work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. Make the necessary changes in the work to correct the condition without extra charge.
- C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

#### 1.14 COST BREAKDOWNS (SCHEDULE OF VALUES):

- A. Within thirty (30) days after acceptance of the Contract, the Contractor shall furnish to the Engineer, one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made in a format approved by the Engineer. Payments will not be made until satisfactory cost breakdowns are submitted.



1.15 HAZARDOUS MATERIALS:

- A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building or site.
- B. Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of their work, ensure that their workers are aware of this potential and what they are to do in the event of suspicion. The Contractor shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.
- C. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.
- D. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise them immediately.
- E. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.
- F. No asbestos or mercury containing materials shall be installed in this project.

1.16 INDEMNIFICATION:

- A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

1.17 TEMPORARY SERVICES:

- A. The Contractor shall arrange any temporary water, electrical and other services which may be required to accomplish the work. Refer also to General and Special Conditions.
- B. All temporary services shall be removed by Contractor prior to completion of work.

1.18 WARRANTY / GUARANTEE

- A. Provide a warranty/guarantee in written form as part of O&M manual stating that all work, materials, equipment and parts are warranted to be free of defect for a minimum period of one year from the date of Substantial Completion. Warranty period and requirements may be expanded in drawings or subsequent specification sections. Repair or replace (owner's option) any defects or failures at no cost to the owner within the warranty period. Issues arising within warranty period must be attended to in a timely manner and in no case exceed four (4) working days. State this in writing as part of O&M manual. Replace defective items to the satisfaction of the Owner's Representative and the Design Professional.

1.19 SURVEY, MEASUREMENTS AND GRADE:

- A. The Contractor shall lay out their work and be responsible for all necessary lines, levels, inverts, elevations and measurements. The Contractor must verify the figures shown on the Plans before laying out the work and will be held responsible for any error resulting from failure to do so.
- B. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.
- C. Should the Contractor discover any discrepancy between actual measurements and those indicated which prevents following good practice or the intent of the contract documents, the Contractor shall promptly notify the Engineer and shall not proceed with this work until the Contractor has received instructions from the Engineer on the disposition of the work.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Provide materials that are new, full weight, of the best quality. Obtain equipment, components and materials from single manufacturer for products of the same kind or category. Provide materials that are listed and labeled and marked for intended location and application.
- B. Provide basis of design products or listed products equivalent in quality, performance, aesthetics, and product support (factory and local) to that specified as basis of design. Products not basis of design are subject to review by the Design Professional and possible rejection. Listing of a product manufacturer by name alone as an equivalent manufacturer shall not equate all products offered by that manufacturer to the basis of design.
- C. Bear all costs incurred from deviation from basis-of-design materials, methods, labor, services, etc. Use of materials, methods, labor, services, etc. that deviate from the basis-of-design will be considered a statement that capacities, requirements, clearances, arrangements, performance, etc. have been checked, verified, found satisfactory, and align with intent of specified work and applicable codes and regulations.

- D. Should deviation from basis of design equipment impact other contractor's scope of work it shall be the responsibility of this contractor to coordinate with and cover these costs in addition to their own. This specifically includes electrical deviations from basis of design.
- E. All manufacturer or contractor provided electrical disconnect switches shall comply with current National Electric Code requirements and rated to meet or exceed the overcurrent device serving the equipment.

### PART 3 - EXECUTION

#### 3.1 GENERAL DIRECTION

- A. Unless specifically indicated, provide all specified and drawn work as required to render all equipment and systems fully operational, including all ancillary, accessory, and support work. Install equipment and materials in strict accordance with manufacturer's written instructions.
- B. In cases where products / materials are furnished by Owner or others, provide the following services: receive, transport and securely store materials on site; remove materials and components from packaging; assemble all materials and components per factory instructions; install, wire and connect materials and components as recommended by manufacturer for a fully operational installation.
- C. Remove and replace items that impede new work installation including but not limited to fencing, doors, gypsum, lift-out panels, and structures to provide pathway for moving equipment into place.
- D. Examine surfaces to receive products for suitable mounting conditions and verify compliance with installation tolerances and other conditions affecting performance of the work. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Equipment shall be installed in accordance with manufactures installation recommendations. Provide and maintain service, maintenance and operating clearances as required by the manufacturer.

#### 3.2 SUPERVISION AND WORKMANSHIP

- A. Workmanship throughout shall conform to the standards of best practice and all labor employed must be competent and qualified to do all the work required.
- B. Contractor shall furnish the services of an experienced superintendent to be in constant charge of the work at all times. The superintendent's qualifications are subject to the review and acceptance by the Owner's Representative. Utilize the same mechanical superintendent throughout the duration of the project.
- C. Provisions shall be made for owner's representative or design professional to make rough-in and open ceiling inspections prior to covering up work.

### 3.3 CHANGE OF WORK

- A. In the event of revised scope or work formally issued through Change of Work order, contractor shall provide an itemized breakdown of pricing and receive approval prior to commencing work.
- B. All pricing shall be in alignment with industry standard labor rates and estimated hours (based on RSMMeans data). Any additional material or equipment shall be passed through with the standard industry excepted mark-up. All labor hours, labor rates, material costs, and equipment costs are subject to further questioning and approval from the Engineer.
- C. All work commencing prior to approval will be at the risk of the contractor.

### 3.4 ARCHITECTURAL COORDINATION ITEMS

- A. Cutting and Patching:
  - 1. Cut and drill all openings in roofs, walls, and floors required for the installation. Neatly patch all openings cut. Hold cutting and patching to a minimum by arranging with other contractors for all sleeves and openings before construction is started.
- B. Fire Caulking:
  - 1. Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. Patch shall be equal to rockwool, firestop, caulk or approved "rated" patch.
  - 2. Provide products equivalent to the following:
    - a. For Floor Openings: 3M; Fire Barrier Sealant CP 25WB+
    - b. For Wall Openings: 3M; Fire Barrier Sealant CP 25WB+
    - c. Mineral Felt: Rockwool; Firepro Firestop Compound
    - d. For Insulated Pipes: 3M; Fire Sealant System CAJ5211
    - e. For Fill Areas: 3M; Fire Barrier Packing Material PM 4
  - 3. For larger openings where pipes penetrate fire rated enclosures that cannot be sealed with products described above, utilize approved UL products equal to 3M FireDam Spray 200.
- C. Access Panels:
  - 1. Provide all access panels required for proper servicing of equipment. Provide fire rated access panels at fire rated assembly penetrations rated at or above the fire rating of the assembly. Provide frame as required for finish. Coordinate installation with General Contractor as they may elect to install access panel. Exact location(s) must be approved by the Architect. Minimum size to be 12" x 12", units to be 16-gauge steel, primed for paint, and locking device shall be screwdriver cam locks.
  - 2. For equipment above gypsum board or "hard ceilings", provide equipment access panels sized to permit complete holistic removal of the unit in its entirety. Access panel shall also be sized to accommodate removal of the largest piece of equipment in the case where such access panel is used as a removal pathway for multiple pieces of equipment.
- D. Piping Sleeves:

1. Install standard Schedule 40 black steel pipe sleeves two sizes larger than pipes passing through floors, walls or masonry construction. Cut flush with both faces of wall. Floor sleeves shall extend one inch above floor top elevation. Roof penetrations shall be within a pipe curb assembly equal to Pate Co. Curb and flashing per roofing manufacturer's requirements to maintain warranty.
2. Install rockwool and/or caulk between pipe and sleeve. Material must meet all applicable fire ratings.

E. Piping Escutcheon plates:

1. Install manufactured chromium plated escutcheon plates wherever uninsulated exposed pipes pass through walls, floors, or ceilings. Escutcheon inside diameter to closely fit around pipe and outside diameter to completely cover opening.

F. Expansion Joints:

1. Provide flexible connectors where all pipes or ducts cross building expansion joints. Coordinate exact quantity & location with Architectural plans prior to installation of piping or ductwork.

### 3.5 PROTECTION OF EQUIPMENT AND SURFACES

- A. Make every effort to protect roofs, walls and floors from foot traffic, equipment, carts, lifts, etc.
- B. Make roof penetrations and install insulated roof curbs and flashing in accordance with roofing manufacturer's recommendations. Obtain written certification from roofing manufacturer that work has been performed properly and that roof warranty is intact.
- C. The Contractor shall be entirely responsible for all material and equipment they furnish in connection with their work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All piping, etc., shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced by the Contractor at their expense. All ductwork with open ends shall be covered with plastic during construction.

### 3.6 REQUIRED CLEARANCES FOR ELECTRICAL EQUIPMENT

- A. The NEC has specific required clearances above, in front, and around electrical gear, panels etc. The Contractor shall not install any piping, ductwork, etc., in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated at no additional cost. Coordinate with the Electrical Contractor prior to any work.

### 3.7 EQUIPMENT SUPPORT

- A. Each piece of equipment, apparatus, piping, or conduit suspended from the ceiling or mounted above the floor level shall be provided with suitable structural support, pipe stand, platform or carrier in

accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and piping. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc. Do not support items from roof/floor deck or bridging.

### 3.8 DUCT AND PIPE MOUNTING HEIGHTS

- A. All exposed or concealed ductwork, piping, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed piping and ductwork shall, insofar as possible, run perpendicular or parallel to the building structure. Refer to Plans for minimum heights of ducts and piping. Minimum height above ceilings shall be 6” clear including insulation, unless otherwise noted.

### 3.9 BROKEN LINES AND PROTECTION AGAINST FREEZING

- A. No conduits, piping, etc. carrying water or any other fluid subject to freezing shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor whether or not insulation is specified or indicated on the particular piping. All damages resulting from broken and/or leaking lines shall be replaced or repaired at the Contractor's own expense. Do not install piping across or near openings to the outside whether or not they are carrying static or moving fluids. Insulation on piping does not necessarily ensure that freezing will not occur. If in doubt, contact the Engineer.

### 3.10 WEATHERPROOFING:

- A. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as specified and approved by the Architect and Engineer before work is performed. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings permanently watertight.
- B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

### 3.11 FINAL CONNECTIONS TO EQUIPMENT:

- A. The Contractor shall finally connect mechanical services (water, sanitary, gas, air, etc.), to any terminal equipment, appliances, kitchen equipment, etc., provided under this and/or other divisions of the work. Various equipment connections indicated are based upon “basis of design” equipment selections. Should alternate equipment be purchased by the General Contractor, then this Contractor shall make the necessary provisions in the Bid for any and all differences. Change Orders shall not be considered for any differences due to alternate equipment purchase. Such connections shall be made in strict accord with current codes, safety regulations and the equipment manufacturer’s recommendations. If in doubt, contact the Engineer prior to installation.

### 3.12 UTILITY VERIFICATION REQUIREMENTS

- A. Field verify locations of underground and aboveground utilities, or those otherwise obscured from view, in the vicinity of work prior to commencing work. Utilize “811” call before you dig and hire locating service to identify, locate and mark remaining utilities and private lines.
- B. Camera scope and dye testing existing piping, ductwork and pathways to confirm existing conditions and use including, but not limited to, voltage, natural gas pressure, sanitary, storm, chilled water, steam, etc.)
- C. Obtain on-site approval from local utility prior to connecting to existing services.
- D. Failure to perform the above shall result in contractor proceeding at their risk and accepting full responsibility for incorrect connections.

### 3.13 ACCESSIBILITY:

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and ceilings for the proper installation of their work. They shall cooperate with all others whose work is in the same space. Such spaces and clearances shall, however, be kept to the minimum size required.
- B. The Contractor shall locate and install all equipment so that it may be serviced, and maintained as recommended by the manufacturer. Allow ready access and removal of the entire unit and/or parts such as valves, filters, fan belts, motors, prime shafts, controls, coils, etc.
- C. Whether shown on the Plans or not, the Contractor shall provide in the Bid access panels for each concealed shut-off valve, motorized control damper, manual air damper or other device requiring service as shown on Engineer's Plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. Change orders for access panels will not be accepted.

### 3.14 SCAFFOLDING, RIGGING AND HOISTING:

- A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery onto the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

### 3.15 DELIVERY, STORAGE, HANDLING, AND PROTECTION

- A. Receive, inspect, store and protect all materials required for new work. Do not accept or install any product damaged in any way.
- B. Comply with all manufacturer guidelines and requirements for movement, storage, and protection of new work. All new work must be stored in a clean, dry place protected from weather and construction

traffic. Maintain acceptable temperature and humidity per manufacturer recommendations. When stored inside or during transport through building, do not exceed structural capacity of the floor.

- C. Coordinate and account for sizes of all new work included shipping materials with available openings. Account for rigging of all new work as required and as intended by manufacturer.
- D. Do not install work until work area is sufficiently weathertight, all wet work in area is complete and all work above is complete.
- E. Prior to installation, all products shall have the ability to be returned to the supplier or manufacturer after purchase and charged a reasonable restocking fee equal to a small portion of the cost.
- F. Protect all new work through construction from damage. Take safeguards necessary to protect from damage. Items damaged during construction will not be accepted and shall be replaced with new.
- G. Remove and replace all materials that have been installed improperly, physically damaged, moisture or water damaged, or mold damaged.
- H. Fully remove all packaging materials inside and out prior to startup.

### 3.16 LOW VOLTAGE CONTROL WIRING FOR MECHANICAL EQUIPMENT

- A. 120VAC Temperature Control Circuits
  1. Electrical Contractor shall provide all 120 Volt power wiring as required for temperature control panels and transformers to low voltage. Electrical Contractor shall connect to existing spare at electrical panel board and provide proper circuit breaker per NEC and label panel board accordingly. Mechanical contractor and temperature controls contractor shall coordinate with the electrical contractor accordingly.
  2. All other required 120VAC raceway and wiring related work shall be provided by the Electrical Contractor.
  3. The Electrical Contractor shall coordinate with the General Contractor to ensure thermal envelope is maintained at these locations.

### 3.17 FIRE ALARM RELATED WORK FOR MECHANICAL SYSTEMS

- A. The drawings and specifications for this project require specific fire alarm devices, connections, wiring and programming associated with this division of work.
- B. The electrical contractor will be installing a new fire alarm system or making modifications to an existing fire alarm control panel. Coordinate all fire alarm connections and programming that will be required with the electrical contractor to fulfil this division of work. This coordination shall take place at the start of the project so that all devices may be shown on fire alarm shop drawings.
- C. Fire alarm devices to satisfy the requirements of this division of work will be furnished by the electrical contractor, installed by the mechanical contractor, wired and programmed by the electrical contractor. Mechanical and electrical contractor shall perform and be present for all tests of the system.



- D. All required mechanical shutdowns of equipment shall be coordinated with the electrical contractor and with submitted equipment and performed in a controlled and safe manner in the presence of smoke. This shall be done via hardwired contacts and not via Building Automation System.
  - 1. Whether shown on the drawings or not, all air handling units over 2000 CFM that serve more than one space shall have duct smoke detectors located in the return duct of each unit in accordance with the current State Mechanical Code, and NFPA 90A. The duct smoke detector shall be equipped with an auxiliary relay that immediately cuts power to the fan motor and notifies the fire alarm panel. All related work shall be coordinated accordingly with the electrical contractor. The duct detectors shall be installed downstream of the air filters and ahead of any branch connections in air supply systems having a capacity greater than 2,000 cfm. Where the duct detector cannot be located ahead of branch connections, multiple duct detectors shall be used to satisfy the intent of the code. Return system smoke detectors are not required when the entire space served by the air distribution system is protected by a system of area smoke detectors

3.18 CLEANING:

- A. The Contractor shall, at all times, keep the area of their work presentable to the public and clear from rubbish and debris caused by their operations; and at the completion of the work, they shall remove all rubbish, debris, all of their tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use. If the Contractor does not attend to such cleaning upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the Contractor. The Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of their rubbish or debris.
- B. After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of piping, equipment, fixtures and all other associated or adjacent fabrication.
- C. Ductwork and piping shall be kept clean at all times. Ductwork stored on the job site shall be placed a minimum of 4" above the floor and shall be completely covered in plastic. Installed ductwork shall be protected with plastic. Do not install the ductwork or insulation (pipe or duct) if the building is not "dried-in". If this is required, the entire lengths of duct shall be covered in plastic to protect. The Owner/Engineer shall periodically inspect that these procedures are followed. If deemed unacceptable, the Contractor shall be required to clean the duct system utilizing a NADCA certified Contractor.

3.19 TEMPORARY USE OF EQUIPMENT:

- A. The permanent heating and cooling equipment, when installed, may be used for temporary services, with the consent of the Engineer. Should the permanent systems be used for this purpose the Contractors shall make all temporary connections required at their expense. They shall also make any replacement required due to damage wear and tear, etc., leaving the same in "as new" condition.
- B. Permission to use the permanent equipment does not relieve the Contractors from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

- C. Warranties shall begin at substantial completion regardless of temporary use of equipment or not.
- D. A pre-start-up conference shall be held in accordance with EQUIPMENT/CONTROLS START-UP AND VERIFICATION in this section.
- E. **For Air Handling Units during all phases of construction**
  - 1. **At a minimum, four complete sets of filter media are required for each unit. In each unit, install two sets of filter media during construction (more shall be required if construction activities dictate more frequent changes). In each unit, install one set of filter media at substantial completion. Leave one set of filter media in boxes in appropriate mechanical room as a spare set for the Owner. All other filters shall be used by the Contractor during construction. Dispose of all construction filter media.**
  - 2. **On the outside of all return air openings install a minimum of two sets of fiberglass filter media, such as cheesecloth, to be utilized as pre-filters for the “construction” filters. Install first set upon start-up and then install second set when first set is dirty. Dispose of all dirty construction filters. Change filters as often as necessary to keep units from becoming dirty at no additional cost.**
  - 3. **At substantial completion of the project the entire unit shall be cleaned to present a like “new” unit for the Owner and all filters shall be replaced with new.**

### 3.20 NOISE, VIBRATION OR OSCILLATION

- A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer. In case of moving machinery, sound or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor at their expense.
- B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports whether indicated or not suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc. by means of flexible connectors, vibration absorbers, or other approved means.
- C. Unitary equipment, such as room units, exhaust fans, etc., shall be rigidly braced and mounted to wall, floor or ceiling as required and tightly gasketed and sealed to mounting surface to prevent air leakage and to obtain quiet operation. Flush and surface mounted equipment such as diffusers, grilles, etc., shall be gasketed and affixed tightly to their mounting surface.
- D. The Contractor shall provide supports for all equipment they furnish. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. If strength of supporting structural members is questionable, contact Engineer.

### 3.21 EQUIPMENT/CONTROLS STARTUP & VERIFICATION

- A. The Contractor and their Subcontractors shall include in the bid to provide equipment and controls startup and verification for ALL Mechanical Systems specified for this project.

- B. A pre-start-up conference shall be held with the Architect, Engineer, Owner, General Contractor, Mechanical Contractor, Electrical Contractor, Controls Contractor, Test and Balance Contractor, and the Manufacturer's providing startup services. The purpose of this meeting will be discussing the goals, procedures, etc. for start-up.
- C. Specific line-items shall be included on the schedule of values by each Trade for "equipment and controls startup". These line-item values shall be approved by the Engineer. The Engineer, Owner and the Engineer's Field Inspector(s) shall closely monitor progress and quality of the equipment and controls startup and may withhold pay requests as deemed appropriate until satisfactorily completed.
- D. Specific startup/verification specifications are included throughout the Mechanical Specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians, not third-party contractors, and shall complete and submit start-up reports/checklists. The Contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner. Where factory start-up is not specified for a particular piece of equipment or system, the Contractor shall be responsible to perform start-up. All information shall be completed by the Contractor and submitted to the Owner/Engineer prior to acceptance of the equipment.
- E. The Contractor shall be responsible for completion of System Verification Checklists/Manufacturer's Checklists. Factory startup is required for all HVAC equipment noted. Unless noted otherwise, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians and shall complete and submit start-up reports/checklists.
- F. The manufacturer's recommended startup procedures and checklists will be acceptable for use in the project. Where "manufacturer" startup is not specified, then this Contractor shall perform startup services in strict accordance with manufacturer's instructions. All startup/verification process shall be thoroughly documented by the Contractor and shall include the time and date when performed.
- G. The Contractor shall "zip-tie" a start-up report to each piece of equipment in a clear plastic cover. Once start-up completion is verified by the Engineer the Contractor shall remove all reports and consolidate them into close-out documentation. The Contractor shall be responsible for completion of System Verification Checklist (SVC) / Manufacturer's Checklists.

### 3.22 INSPECTION, APPROVALS AND TESTS:

- A. Before requesting a final review of the installation from the Architect and/or Engineer, each Contractor shall thoroughly inspect their installations to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineer for unnecessary and undue work on their part.
- B. The Contractor shall provide as a part of this Contract any required Agency inspection, licensed and qualified to provide such services. All costs incidental to the provisions of inspections shall be borne by the Contractor.
- C. The Contractor shall advise each Inspecting Agency in writing, with an informational copy of the correspondence to the Architect and/or Engineer, when they anticipate commencing the work.

Inspections shall be scheduled for rough-in as well as finished work. The rough-in inspections shall be divided into as many inspections as may be necessary to cover all rough-in without fail. Failure of the Inspecting Agency to inspect the work in a timely manner and submit the related reports may result in the Contractor having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

- D. Approval by an Agency Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these Plans and Specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.
- E. Before final acceptance, the Contractor shall furnish the original and three (3) copies of the certificates of final approval by the Agency Inspector to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

### 3.23 ABOVE-CEILING AND FINAL PUNCH LISTS:

- A. The Contractor shall review each area and prepare and complete their own punch list for each of the subcontractors as required for the Project Schedule.
- B. Seven (7) days' notice shall be given to the Engineer for review of above ceiling work that will be concealed by tile or other materials. Seven (7) days' notice shall be given to the Engineer for review of below ceiling work and final inspection.
- C. When all work from the Contractor's punch list is complete at each of the major Project Stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven (7) days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review. The Contractor's representative may be requested at the inspections.
- D. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due net 10 days from date of each additional visit) at a rate of \$125.00 per hour plus travel expense for extra trips required to complete either of the above ceiling, below ceiling or final punch lists.

### 3.24 OPERATING INSTRUCTIONS

- A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating the systems and equipment for a period of three (3) days of eight (8) hours each, or as otherwise specified. Refer to Section HVAC EQUIPMENT for additional requirements. During this period, instruct the Owner or their representatives fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least seven (7) days written notice to the Owner, Architect and Engineer in advance of this training period. The Engineer may attend any such training

sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer that such demonstrations have taken place, noting the date, time and names of the Owner's representatives that were present.

- B. Each Contractor shall furnish three complete bound sets for approval to the Engineer instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft form, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions. Refer to Specification Section SHOP DRAWINGS for additional detail.
- C. Each Contractor, in the above-mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

### 3.25 RECORD DRAWINGS:

- A. The Contractor shall insure that any deviations from the Design are as they occur recorded in red, erasable pencil on record drawings kept at the jobsite. The Engineer shall review the record documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose and deliver to the Engineer upon completion of the work.

### 3.26 DEMONSTRATION / TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Refer to product specific specification for training types and duration.

END OF SECTION 230501

SECTION 230505 - EXISTING CONDITIONS AND DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Prior to submitting a bid, the Mechanical Contractor shall perform a detailed walk-through field inspection, to review the existing structures and premises, to determine all existing conditions, equipment/ductwork/piping locations, etc. and shall make all necessary allowances for all required mechanically related demolition and relocation work. This pre-bid inspection by the Mechanical Contractor shall include inspection of all applicable accessible ceiling cavity, areas, etc.
- B. Should the Mechanical Contractor take any exceptions to providing any related demolition or relocation work, such exceptions shall be stated in detail within the Prime Contractor's bid. No subsequent allowance to the contract cost shall be made for any insufficient allowances made by the Mechanical Contractor during bidding which may result from the Mechanical Contractor's failure to visit job site and review drawings.
- C. The Mechanical Contractor shall confirm the working operation and condition of existing systems to remain. The Mechanical Contractor shall note any malfunctioning systems, system deficiencies or any other noteworthy system items prior to commencement of work. The Mechanical Contractor shall provide a written systems condition assessment report to the owner prior to commencement of work. The owner shall sign the assessment report acknowledging the condition of the existing systems. The Mechanical Contractor shall protect these existing systems and shall be responsible for these systems during demolition and construction. The Mechanical Contractor shall be responsible for turning these existing systems back over to the owner in the same operating condition as the contractor received it. The mechanical contractor shall be responsible for repairing or replacing any malfunctioning systems, components or deficient systems to the satisfaction of the owner that have not been noted on the written systems condition assessment report. The mechanical contractor shall be responsible for all existing system components and operation in the absence of an owner-signed systems condition assessment report.
- D. Demolition related work may not be specifically indicated on drawings, but shall be included under base bid. All mechanically related demolition, relocation, etc. work, including work described herein, shall be under base bid.
- E. It is not the intent of these contract documents that existing conditions be accurately shown. Existing mechanical work is shown to a limited extent on drawings and is shown for general planning reference only. Such locations, etc. have been located from portions of contract documents which were prepared for previously installed work (not from "as-builts"). These locations are not guaranteed. The successful Mechanical Contractor shall have access to all available existing building/system plans and specifications.
- F. The existing ductwork and piping systems may be utilized only to the extent indicated herein or on drawings and/or as directed by Owner's representative in field.

- G. Routing of all new ductwork and piping work in existing buildings shall be approved by Owner's representative prior to installation.

## PART 2 - PRODUCTS

### 2.1 NOT USED

## PART 3 - EXECUTION

### 3.1 EFFECT ON ADJACENT OCCUPIED AREAS

- A. Locate, identify, and protect existing mechanical services passing through demolition areas and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services (including proper filtration) for affected areas.
- B. It is recognized that there may be some ductwork and/or piping systems rendered inactive by demolition, causing disconnection of "downstream" terminals, equipment, etc. which serve occupied areas. It shall be the responsibility of the Mechanical Contractor to investigate these types of conditions (for all systems) prior to demolition. Provide all necessary corrective mechanical work prior to demolition to ensure that such "downstream" work remain permanently active throughout demolition, new construction and after project completion.
- C. All work and system shutdowns shall be carefully coordinated in advance with owner's representative and all affected trades so that normal building activities and other construction trades are minimally affected. All required mechanical related demolition and/or new construction work, which will affect any and all occupied areas (including those which are located outside the immediate area of project work) shall be performed at special times if/as directed by Owner's representative in field.
- D. All existing systems and components shall remain fully operational in all occupied spaces during all occupied periods.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent finished areas and/or other system components. During cutting and patching operations, protect adjacent installations. Remove protection and barriers after demolition operations are complete.

### 3.2 WORK IN EXISTING SPACES

- A. General: Care shall be taken when working in existing spaces so as not to damage existing walls and ceilings where work is being performed.

- B. Existing Ceilings: Where work is being performed above existing ceilings, and the architectural drawings do not indicate ceiling modifications by the General Contractor, it shall be the responsibility of this contractor to remove and replace existing ceilings where work is being performed. In those instances, all repair and installation of new grid, ceiling panels, etc shall be the responsibility of this contractor. Match existing finishes.
- C. New Ceilings: Where existing air outlets are to remain, and the architectural drawings indicate replacement of the ceilings, this contractor shall temporarily remove air outlets, clean and store temporarily. This contractor shall support existing run outs to structure to facilitate replacement of ceiling. This contractor shall re-install existing air outlets at previous locations and extend run outs to air outlets after new ceiling is installed. Refer to architectural drawings for all required ceiling replacements. Coordinate with all trades prior to re-installation.
- D. Walls & Floors: It shall be the responsibility of this contractor to patch existing walls and floors and match existing finishes where work is being removed or installed and patching is being performed, unless noted otherwise on the architectural drawings.
- E. HVAC Units: Replace all air filters in all HVAC equipment serving renovated space prior to turning space over to owner.
- F. If asbestos, PCB's, or other hazardous materials are encountered in the course of the work, stop work in the vicinity of such materials and report their presence to the Owner. Owner will arrange for proper removal and disposal of hazardous materials.

### 3.3 GENERAL DEMOLITION

- A. Provide complete mechanical demolition as required for all systems throughout all project areas not indicated to be salvaged or saved. Unless specifically noted otherwise on plans or determined otherwise during this contractor's pre-demolition survey, all abandoned existing mechanical work in the project areas shall be disconnected and removed in its entirety by the Mechanical Contractor. All related work shall comply with the notes specified herein.
- B. Provide demolition work as required to clear and remove all existing mechanical work to be abandoned and as required to accommodate all new work of all trades. In general, remove existing related ductwork, piping, control media, etc. back to nearest concealed accessible terminal or take-off "upstream". Extend ductwork, piping, etc. as required to accommodate new or relocated mechanical work.
- C. Remove abandoned, inactive and obsolete equipment, ductwork, piping, etc. Abandoned work embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove all abandoned materials above accessible ceilings.
- D. Perform cutting and patching required for demolition in accordance with the contract documents.
- E. All abandoned ductwork and piping shall be removed and capped back to respective sources, even if sources are outside of the confines of the project area. Coordinate all work carefully with Owner prior to beginning any mechanical demolition work.



- F. All ductwork, piping, etc. conflicting with construction related work of any and all trades shall be removed and/or relocated by the Mechanical Contractor as necessary and/or as directed by Owner's representative in the field. Mechanical disconnections (and/or reconnections) for equipment to be removed (and/or relocated) shall be by the Mechanical Contractor. This shall apply to all existing mechanical work whether shown on drawings or not.
- G. All refrigerant evacuations and reclaim shall be required for demolished or relocated equipment.
- H. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- I. Provide new work as required to accommodate relocations, etc. Routing of all new ductwork and piping in existing buildings shall be held tight to structure above wherever possible and shall be approved by owner's representative prior to installation.

### 3.4 DISPOSITION OF REMOVED EQUIPMENT & MATERIALS

- A. If required to accommodate construction related activities, remove and reinstall any conflicting fixtures, devices or equipment that are to remain.
- B. All abandoned materials removed during demolition and thereafter shall be referred to the Owner's representative for disposal instructions. All materials which the Owner elects to retain shall be neatly stored at the site by the Mechanical Contractor as designated by the Owner's representative. All materials which the Owner elects not to retain shall be disposed of by the Mechanical Contractor in a lawful manner.
- C. All fixtures, devices or equipment designated for salvage (removal and reuse, or for turning over to Owner) shall be disconnected and removed undamaged. Disconnect all pigtails, etc. from equipment terminal points and carefully transport and neatly store same to a protected on-site storage location as directed in field.
- D. Components to be reused shall be cleaned (inside and out) and reinstalled where indicated on drawings. Modify and/or extend related existing ductwork and/or piping as required.
- E. Components turned over to Owner shall be neatly stored as groups by system type.

### 3.5 PRE-EXISTING CODE VIOLATIONS

- A. All existing work which is accessed and/or used under this project shall be inspected and brought into compliance with current codes and standards by the Mechanical Contractor. This shall apply only to the extent that such work is uncovered in the immediate project areas affected by demolition and/or new construction and only to the limited extent that it applies to pre-existing general installation methods (i.e. a missing hanger/support, a missing seal and other minor incidental work).
- B. If more extensive code or safety violations are discovered by the Mechanical Contractor, they shall be immediately brought to the attention (detailed in writing) of the Owner's representative along with the contractors proposed cost for corrections.

3.6 INTERIM LIFE SAFETY WORK

- A. Provide interim fire protection (sprinkler) work in all demolition and construction areas for full code coverage. Further definition will be provided in field if required.

3.7 INTERIM INDOOR AIR QUALITY (IAQ) WORK

- A. All requirements of this IAQ subsection shall be implemented prior to commencement of any demolition/construction activities.
- B. No airborne dust or particulate matter shall be permitted to enter any occupied spaces or any air intakes to existing systems.
- C. Become familiar with all affected HVAC systems to ensure that positive pressure can be maintained, relative to construction areas, in all areas adjacent to construction areas. This shall include all possible operational sequences of all systems such, including operation of smoke control, fire dampers, etc.
- D. All return air and exhaust air terminals within all demolition/construction spaces shall be covered and properly sealed until construction is complete.
- E. All air filters shall be checked at the beginning and end of each work shift and shall be changed in-kind as required to permit free airflow at all times.
- F. Provide temporary exhaust throughout all demolition/construction spaces to ensure proper negative pressure is maintained relative to adjacent areas, including allowances for normal construction traffic through all access doors. Ensure that no windows or doors are left open which could upset the desired negative pressure.
- G. Designate a dedicated qualified person to be on site to monitor all IAQ requirements, including checking filters three to four times per shift, checking for any breeches (by any contractor) such as drilled/cut openings in walls/floors, open windows, etc. Ensure that openings through walls and floors (by any contractor) are made immediately prior to installation of work and properly/permanently sealed immediately thereafter.

END OF SECTION 230505

## SECTION 23 05 29.00 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Metal pipe hangers and supports
  - 2. Trapeze pipe hangers
  - 3. Metal framing systems
  - 4. Thermal-hanger shield inserts
  - 5. Fastener systems
  - 6. Equipment supports
- B. Related Sections:
  - 1. Section 055000.00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
  - 2. Section 230503.00 "Submittals for HVAC".
  - 3. Section 230516.00 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
  - 4. Section 232113.23 "Aboveground Hydronic Piping and Specialties".
  - 5. Section 233113.00 "Metal Ducts" and Section 233116.00 "Nonmetal Ducts" for duct hangers and supports.

#### 1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines to Terminology for Pipe Hangers and Supports"

#### 1.4 PERFORMANCE REQUIREMENTS

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

- B. Structural Performance: Hangers and supports for HVAC piping, and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Metal pipe hangers and supports.
  - 2. Thermal-hanger shield inserts.
  - 3. Powder-actuated fastener systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
  - 1. Trapeze pipe hangers including product data for components
  - 2. Metal framing systems including product data for components
  - 3. Equipment supports

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

#### 1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

### PART 2 - PRODUCTS

#### 2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped for hangers in contact with galvanized piping.
  - 3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

4. Hanger Rods: Continuous-thread rod, nuts, and washer made of steel or stainless steel in moist area.

B. Copper Pipe Hangers:

1. Nonmetallic Coatings: Plastic coating, jacket, or liner for hangers in contact with copper piping.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

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

1. Anvil International, Inc.
2. B-Line Systems, Inc. (a division of Cooper Industries)
3. ERICO/Michigan Hanger Company
4. PHD Manufacturing, Inc

## 2.2 TRAPEZE PIPE HANGERS

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

## 2.3 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100 psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ERICO International Corporation.
  2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
  3. Rilco Manufacturing Co., Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hilti, Inc.
    - b. ITW Ramset/Red Head
    - c. MKT Fastening, LLC
    - d. Powers Fasteners.
  
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hilti, Inc
    - b. ITW Ramset/Red Head
    - c. MKT Fastening, LLC
    - d. Powers Fasteners

## 2.5 EQUIPMENT SUPPORTS

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

## 2.6 ROOF EQUIPMENT SUPPORTS

- A. Equipment supports: Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints and integrally formed deck-mounting flange at perimeter.
- B. Support Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated galvanized steel sheet, 0.052 inch thick.
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Curbs Plus, inc.
  - 2. Pate Company (The)
  - 3. Roof Products, Inc.
  - 4. Thybar Corporation

## 2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

### PART 3 - EXECUTION

#### 3.1 HANGER AND SUPPORT INSTALLATION

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
- B. Do not suspend hangers from roof decks. Suspend from roof trusses, joists and joist girders only at panel points and at top chords unless otherwise indicated.
- C. All piping hangers in exterior spaces, such as parking garages, exposure to high humidity, etc., or in interior swimming pool areas shall be galvanized.
- D. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- E. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- F. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- G. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and attachments for general service applications.
- H. Use padded hangers for piping that is subject to scratching.
- I. All mechanical equipment shall have concrete bases and/or structural steel supports and shall be provided by this contractor.
- J. The use of pumps or other equipment as piping supports shall be prohibited. All such connectors and their supports shall be independently supported from the building structure and inspected and approved by the Engineer before bolting.
- K. Piping connections to all equipment with moving parts shall be isolated with braided copper or stainless steel flexible links, which shall be selected to absorb the deflection on the isolating members.

- L. Use thermal-hanger shield inserts for insulated piping and tubing.
- M. Hangers: Provide adjustable, Steel Clevis Hangers (MSS Type 1) for suspension of noninsulated or insulated, stationary pipes.
- N. Horizontal-Piping Clamps: Provide Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3) for suspension of pipes requiring clamp flexibility and up to 4 inches of insulation.
- O. Vertical-Piping Clamps: Provide extension pipe or Riser Clamps (MSS Type 8) for support of pipe risers.
- P. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- Q. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Inserts:
    - a. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from structural concrete ceiling.
  - 2. Clamps:
    - a. C-Clamps (MSS Type 23): For structural shapes.
    - b. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  - 3. Miscellaneous:
    - a. Welded Beam Attachments (MSS Type 22): For attaching to bottom of steel beams if loads are considerable and rod sizes are large.
    - b. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      - 1) Light (MSS Type 31): 750 lb.
      - 2) Medium (MSS Type 32): 1500 lb.
      - 3) Heavy (MSS Type 33): 3000 lb.
    - c. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
    - d. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- R. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  - 2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- S. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- T. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.



- U. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- V. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- W. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- X. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- Y. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- Z. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- AA. Install lateral bracing with pipe hangers and supports to prevent swaying.
- BB. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, guides, expansion joints, strainers and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- CC. Provide pipe rollers for hot water mains where piping is above 140 degrees. Provide pipe rollers approved equal to Anvil Fig. 171, 175, 177, 181 and 271.
- DD. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- EE. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- FF. Insulated Piping:
  - 1. Attach clamps and spacers to piping.

- a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation. Do not exceed pipe stresses allowed by manufacturer.
  - b. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
  - c. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
  - d. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  3. Shields:
    - a. Install protective galvanized steel shields, MSS Type 40, on insulated piping smaller than 2-inch NPS. Shields shall span an arc of 180 degrees and shall be a minimum of 12-inches in length.
    - b. Install thermal-hanger shield inserts on all insulated piping 2-inch NPS and larger.
  4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports. Install and align fabricated anchors in indicated locations.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.
  4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Piping:

| Piping Material | Pipe Size              | Hanger Spacing (OC) |
|-----------------|------------------------|---------------------|
| Steel           | NPS 1-1/4" and smaller | 8'-0"               |
| Steel           | NPS 1-1/2" to NPS 2"   | 10'-0"              |
| Steel           | NPS 2-1/2" and larger  | 12'-0"              |
| Copper          | 1" and smaller         | 6'-0"               |
| Copper          | 1-1/4" and larger      | 8'-0"               |

- 1. In addition to supported pipe information above, support piping at each change in direction.

END OF SECTION 23 05 29.00

## SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Brimar Industries, Inc.
    - c. Carlton Industries, LP.
    - d. Champion America.
    - e. Craftmark Pipe Markers.
    - f. emedco.
    - g. Kolbi Pipe Marker Co.
    - h. LEM Products Inc.
    - i. Marking Services, Inc.
    - j. Seton Identification Products; a Brady Corporation company.
  - 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
  - 3. Letter Color: White
  - 4. Background Color: Black
  - 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  - 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for

- greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
  9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
  2. Brimar Industries, Inc.
  3. Carlton Industries, LP.
  4. Champion America.
  5. Craftmark Pipe Markers.
  6. emedco.
  7. Kolbi Pipe Marker Co.
  8. LEM Products Inc.
  9. Marking Services, Inc.
  10. Seton Identification Products; a Brady Corporation company.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: White
- D. Background Color: Red
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- J. Label Content: Include caution and warning information plus emergency notification instructions.

### 2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  2. Brady Corporation.
  3. Brimar Industries, Inc.
  4. Carlton Industries, LP.
  5. Champion America.
  6. Craftmark Pipe Markers.
  7. emedco.
  8. Kolbi Pipe Marker Co.
  9. LEM Products Inc.
  10. Marking Services Inc.
  11. Seton Identification Products; a Brady Corporation company.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  2. Lettering Size: Size letters according to ASME A13.1 for piping and at least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

### 2.4 DUCT LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
  2. Brimar Industries, Inc.
  3. Carlton Industries, LP.
  4. Champion America.
  5. Craftmark Pipe Markers.
  6. emedco.
  7. Kolbi Pipe Marker Co.
  8. LEM Products Inc.
  9. Marking Services Inc.
  10. Seton Identification Products; a Brady Corporation company.

- B. General Requirements for Manufactured Duct Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
  - 2. Lettering Size: Size letters at least 1 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
- E. Letter Color: White
- F. Background Color: Varies by duct type. See schedules below.
- G. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

## 2.5 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Brady Corporation.
  - 2. Brimar Industries, Inc.
  - 3. Carlton Industries, LP.
  - 4. Champion America.
  - 5. Craftmark Pipe Markers.
  - 6. emedco.
  - 7. Kolbi Pipe Marker Co.
  - 8. LEM Products Inc.
  - 9. Marking Services Inc.
  - 10. Seton Identification Products; a Brady Corporation company.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
  - 1. Size: 3 by 5-1/4 inches minimum.
  - 2. Fasteners: Brass grommet and wire.
  - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  - 4. Color: Safety-yellow background with black lettering.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

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

#### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

#### 3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

#### 3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
  - 1. Chilled-Water Piping: White letters on a safety-green background
  - 2. Condenser-Water Piping: White letters on a safety-green background



3. Heating Water Piping: White letters on a safety-green background
4. Refrigerant Piping: White letters on a safety-purple background
5. Low-Pressure Steam Piping: White letters on a safety-gray background
6. High-Pressure Steam Piping: White letters on a safety-gray background
7. Steam Condensate Piping: White letters on a safety-gray background

### 3.5 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
  1. Blue for cold-air supply ducts.
  2. Yellow for hot-air supply ducts.
  3. Green for exhaust-, outside-, relief-, return-, and mixed-air ducts.

### 3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 230553

## SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

#### 1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualification to perform TAB work.
- F. TDH: Total dynamic head.
- G. UFAD: Underfloor air distribution.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- B. Certified TAB reports.
- C. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

#### 1.4 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC, NEBB, or TABB
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by one of the agencies above.
  - 2. TAB Technician: Employee of the TAB specialist and certified by one of the agencies above.

- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
  - 1. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

## 1.5 FIELD CONDITIONS

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

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.
- F. Examine equipment performance data, including fan curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment

performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, and verify that they are accessible and their controls are connected and functioning.
- K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.
- L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
- Q. 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.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Airside:

- a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
- b. Duct systems are complete with terminals installed.
- c. Volume, smoke, and fire dampers are open and functional.
- d. Clean filters are installed.
- e. Fans are operating, free of vibration, and rotating in correct direction.
- f. Variable-frequency controllers' startup is complete and safeties are verified.
- g. Automatic temperature-control systems are operational.
- h. Ceilings are installed.
- i. Windows and doors are installed.
- j. Suitable access to balancing devices and equipment is provided.

2. [Hydronics:

- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
- b. Piping is complete with terminals installed.
- c. Water treatment is complete.
- d. Systems are flushed, filled, and air purged.
- e. Strainers are pulled and cleaned.
- f. Control valves are functioning in accordance with the sequence of operation.
- g. Shutoff and balance valves have been verified to be 100 percent open.
- h. Pumps are started and proper rotation is verified.
- i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- j. Variable-frequency controllers' startup is complete and safeties are verified.
- k. Suitable access to balancing devices and equipment is provided.]

3.3 PREPARATION AND COORDINATION REQUIREMENTS – GENERAL

- A. Shop drawings, submittal data, up-to-date revisions, change orders, and other data required for planning, preparation, and execution of the TAB work shall be provided to the TAB Agency no later than 30 days prior to the start of TAB work.
- B. System installation and equipment startup shall be complete prior to the TAB Agency's being notified to begin.
- C. The building control system shall be complete and operational. The Building Control system (sub)contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.
- D. All test points, balancing devices, identification tags, etc. shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.
- E. Qualified installation or startup personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.

3.4 PREPARATION AND COORDINATION REQUIREMENTS – HVAC CONTROLS

- A. Written notice shall be submitted through the General Contractor to the Architect-Engineer stating that the Control System is operating and controlling the HVAC System.
- B. The Contractor/Control (sub)contractor shall have entered all data needed for the TAB Agency to begin work.
- C. The Contractor/Control (sub)contractor shall be available to correct any problems that the TAB Agency may encounter with the systems.
- D. All costs for additional work by the TAB Agency due to the Contractor's failure to comply with the above shall be paid by the Contractor and any subcontractor(s) for HVAC controls.

3.5 PREPARATION AND COORDINATION REQUIREMENTS – MECHANICAL

- A. Written notice shall be submitted through the General Contractor to the Architect stating that the HVAC system is operational and ready for the TAB Agency.
- B. The Contractor/Mechanical subcontractor shall have proved all units operational and all air outlets in the full open position.
- C. The Contractor/Mechanical subcontractor shall be available to correct any problems that the TAB Agency might have with any equipment or systems.
- D. The Contractor/Mechanical subcontractor shall furnish and install any replacement sheaves, pulleys and drive belts required for flow adjustments, as determined by the TAB Agency. Adjustable sheaves shall be selected so that the final adjustment position is in the middle third of the total adjustment range.
- E. All costs for additional work by the TAB Agency due to the Contractor's failure to comply with the above shall be paid by the Contractor and any subcontractor(s) for mechanical work.

3.6 PREPARATION AND COORDINATION REQUIREMENTS – DUCTWORK

- A. Ductwork air leakage testing shall be performed by the TAB Agency.
- B. The ductwork/sheetmetal subcontractor shall promptly correct any related problems discovered by the leakage tests.
- C. All costs associated with retesting and/or delays or other problems which impede the TAB Agency from performing such testing shall be paid by the contractor and any subcontractor(s) for ductwork.

3.7 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance, NEBB's "Procedural

Standards for Testing, Adjusting, and Balancing of Environmental Systems ", or ASHRAE 111 for LEED Projects.

- B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
  - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.8 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

- A. Test, adjust, and balance HVAC equipment indicated on Drawings.

### 3.9 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' Record drawings duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.

### 3.10 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
  - 2. Measure fan static pressures as follows:
    - a. Measure static pressure directly at the fan outlet or through the flexible connection.
    - b. Measure static pressure directly at the fan inlet or through the flexible connection.
    - c. Measure static pressure across each component that makes up the air-handling system.
    - d. Report artificial loading of filters at the time static pressures are measured.
  - 3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  - 4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
  - 1. Measure airflow of submain and branch ducts.
  - 2. Adjust submain and branch duct volume dampers for specified airflow.
  - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
  - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
  - 2. Measure inlets and outlets airflow.
  - 3. Adjust each inlet and outlet for specified airflow.
  - 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
  - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.



2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

### 3.11 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
  1. Check expansion tank for proper setting.
  2. Check highest vent for adequate pressure.
  3. Check flow-control valves for proper position.
  4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
  5. Verify that motor controllers are equipped with properly sized thermal protection.
  6. Check that air has been purged from the system.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.
- F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
  1. Check settings and operation of each safety valve. Record settings.

### 3.12 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.
- B. Adjust the variable-flow hydronic system as follows:
  1. Verify that the pressure-differential sensor(s) is located as indicated.
  2. Determine whether there is diversity in the system.
- C. For systems with no flow diversity:
  1. Adjust pumps to deliver total design flow.

- a. Measure total water flow.
    - 1) Position valves for full flow through coils.
    - 2) Measure flow by main flow meter, if installed.
    - 3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
  - b. Measure pump TDH as follows:
    - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    - 3) Convert pressure to head and correct for differences in gauge heights.
    - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
    - 5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
  - c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
2. Adjust flow-measuring devices installed in mains and branches to design water flows.
    - a. Measure flow in main and branch pipes.
    - b. Adjust main and branch balance valves for design flow.
    - c. Re-measure each main and branch after all have been adjusted.
  3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
    - a. Measure flow at terminals.
    - b. Adjust each terminal to design flow.
    - c. Re-measure each terminal after it is adjusted.
    - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    - e. Perform temperature tests after flows have been balanced.
  4. For systems with pressure-independent valves at terminals:
    - a. Measure differential pressure and verify that it is within manufacturer's specified range.
    - b. Perform temperature tests after flows have been verified.
  5. For systems without pressure-independent valves or flow-measuring devices at terminals:
    - a. Measure and balance coils by either coil pressure drop or temperature method.



- a. Measure flow in main and branch pipes.
- b. Adjust main and branch balance valves for design flow.
- c. Re-measure each main and branch after all have been adjusted.

### 3.13 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

### 3.14 DUCT LEAKAGE TESTS

- A. Witness the duct leakage testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

### 3.15 PIPE LEAKAGE TESTS

- A. Witness the pipe pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.

### 3.16 HVAC CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
  1. Verify HVAC control system is operating within the design limitations.
  2. Verify that controllers are calibrated and function as intended.
  3. Verify that controller set points are as indicated.
  4. Verify the operation of lockout or interlock systems.
  5. Verify the operation of valve and damper actuators.
  6. Verify that controlled devices are properly installed and connected to correct controller.
  7. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
  8. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

### 3.17 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
  - 1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
  - 2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
  - 3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
  - 4. Check the refrigerant charge.
  - 5. Check the condition of filters.
  - 6. Check the condition of coils.
  - 7. Check the operation of the drain pan and condensate-drain trap.
  - 8. Check bearings and other lubricated parts for proper lubrication.
  - 9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
  - 1. New filters are installed.
  - 2. Coils are clean and fins combed.
  - 3. Drain pans are clean.
  - 4. Fans are clean.
  - 5. Bearings and other parts are properly lubricated.
  - 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
  - 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
  - 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
  - 3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
  - 4. Balance each air outlet.

### 3.18 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
  - 2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
  - 3. Heating-Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

### 3.19 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

### 3.20 FINAL REPORT

- A. Final TAB Report – The TAB Agency shall submit the final TAB report for review by the engineer. All equipment including but not limited to fans, outlets, traverses, static pressure profiles, pumps, coils, etc. shall be identified in the report. The report must also include, at minimum, electronic drawings that correspond to all test points for additional report clarification. The TAB Agency shall submit an “National Project Performance Guarantee” assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and National Standards.
- B. Submit three (3) electronic copies of the Final TAB Report to the Architect-Engineer, and (1) electronic copy to the Project Manager from the Division of Engineering and Contract Administration. A maximum of three (3) additional hard copies shall be submitted on request.
- C. Payments for the TAB work shall be contingent upon the proper submittal and approval of the TAB reports.

### 3.21 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. Also notify the mechanical project representative from the Division of Engineering and Contract Administration.

- 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.

END OF SECTION 230593

## SECTION 23 07 13.00 - DUCT INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes insulating the following duct services:
  - 1. HVAC Ductwork.
- B. Related Sections:
  - 1. Section 23 05 03 "Submittals for HVAC".
  - 2. Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment".
  - 3. Section 23 31 13 "Metal Ducts".

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, and accessories.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
  - 3. Detail application at linkages of control devices.
- D. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, installed R-values and accessories.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation



materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

- C. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ANSI/ASTM E 84 and NFPA 255, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
- C. Installed R-Values for insulation on ducts shall comply with local mechanical and energy code as required for indoor applications.
- D. Insulation tape shall comply with UL 181.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

#### 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing duct systems. Insulation application may begin on segments that have satisfactory test results.

### PART 2 - PRODUCTS

#### DUCT INSULATION

## 2.1 DUCTWORK INSULATION MATERIALS

- A. Manufacturers
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corp.; SoftTouch Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Friendly Feel Duct Wrap.
    - d. Owens Corning; SOFTR All-Service Duct Wrap.
    - e. Thermaduct, LLC
- B. Interior (indoor) ductwork insulation shall have a minimum installed thermal resistance value of R6 or code minimum, whichever higher.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, without facing and with vapor barrier Type II with factory-applied kraft paper, reinforcing scrim, aluminum foil and vinyl jackets.
- E. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB. For duct and plenum applications, provide insulation without facing and with vapor barrier with factory-applied kraft paper, reinforcing scrim, aluminum foil and vinyl jacket.
- F. Vapor Barrier Material for Ductwork: Paper-backed aluminum-foil, except as otherwise indicated; strength and permeability rating equivalent to factory-applied vapor barriers on adjoining ductwork insulation, where available; with following additional construction characteristics:
  1. High Puncture Resistance: Low vapor transmission (for ducts in exposed, high traffic areas susceptible to damage: Mech. Rooms, etc.)
  2. Moderate Puncture Resistance: Medium vapor transmission (for ducts in concealed areas).
- G. Ductwork Insulation Accessories: Staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- H. Ductwork Insulation Compounds: Cements, mastics, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

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

### 3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

C. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.

D. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated

E. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed. Duct lining thermal resistance value shall comply with external duct wrap requirements.

F. Corner Angles: Install corner angles on external corners of insulation on ductwork in exposed finished spaces.

G. Provide insulation on collar and backside of supply diffusers in all ceiling spaces. Provide insulation on plenum box of all supply grilles and registers in all ceiling spaces.

H. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

I. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

J. Install insulation with longitudinal seams at top and bottom of horizontal runs.

K. Install multiple layers of insulation with longitudinal and end seams staggered.

L. Keep insulation materials dry during application and finishing.

M. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

- N. Install insulation with least number of joints practical.
- O. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- P. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- Q. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- S. Do not overly compress insulation which will result in decreased thermal resistance properties. Install insulation as recommended by the insulation manufacturer.
- T. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### 3.4 DUCT INSULATION SCHEDULE, GENERAL

- A. All ductwork shall be insulated except:
  - 1. Double-Wall duct.
  - 2. Fibrous-glass ducts.
  - 3. Fabric ductwork.
  - 4. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
  - 5. Factory-insulated flexible ducts.
  - 6. Factory-insulated plenums and casings.
  - 7. Flexible connectors.
  - 8. Vibration-control devices.
  - 9. Factory-insulated access panels and doors.
  - 10. Supply ductwork exposed in conditioned spaces excluding mechanical rooms, server rooms and electric equipment rooms.
  - 11. Toilet exhaust, general exhaust and return ductwork in an insulated joist or attic space.
- B. Grilles, Registers, and Diffusers:
  - 1. Provide insulation on collar and backside of supply diffusers in all ceiling spaces. Provide insulation on plenum box of all supply grilles & registers in all ceiling spaces.

### 3.5 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):  
Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
- C. Insulation Installation at Floor Penetrations:
  - 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

### 3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.7 PROTECTION AND REPLACEMENT

- A. Repair damaged vapor barrier using vapor barrier tape to fully cover torn area.
- B. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- C. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 23 07 13.00

## SECTION 23 07 19.00 - HVAC PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
  - 1. [Chilled-water piping.]
  - 2. [Heating hot-water piping.]
- B. Related Sections:
  - 1. Section 23 05 03 "Submittals for HVAC".
  - 2. Section 23 07 13 "Duct Insulation."
  - 3. Section 23 07 16 "HVAC Equipment Insulation."

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.
- C. Schedule: Submit schedule showing insulation products which will be used for each application, indicating thickness, density, and accessories.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation

materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

- C. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ANSI/ASTM E 84 and NFPA 255, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

## 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

## 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 - PRODUCTS

## 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Pittsburgh Corning Corporation; Foamglass.
    - b. Caltherm Insulation.
    - c. Johns Manville.
  - 2. Block Insulation: ASTM C 552, Type I.
  - 3. Special-Shaped Insulation: ASTM C 552, Type III.
  - 4. Board Insulation: ASTM C 552, Type IV.
  - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  - 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
  - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; SoffTouch Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Friendly Feel Duct Wrap.
    - d. Owens Corning; SOFTR All-Service Duct Wrap.
- H. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; Micro-Lok.
    - b. Knauf Insulation; 1000-Degree Pipe Insulation.
    - c. Owens Corning; Fiberglas Pipe Insulation.
- I. Vapor Barrier Material: Paper-backed aluminum foil, except as otherwise indicated, strength and permeability rating equivalent to adjoining pipe insulation jacketing



## 2.2 INSULATING CEMENTS

Mineral-fiber insulating cement is suitable for temperatures from 100 to 1600 deg F (38 to 871 deg C).  
Vermiculite insulating cement is suitable for temperatures from 100 to 1800 deg F (38 to 982 deg C).

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Ramco Insulation, Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Ramco Insulation, Inc.; Thermokote V.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    - d. Mon-Eco Industries, Inc.; 22-25.
- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
    - b. Eagle Bridges - Marathon Industries; 501.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
    - d. Mon-Eco Industries, Inc.; 55-10.
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
  - 3. Service Temperature Range: 0 to 180 deg F.
  - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
  - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    - b. Eagle Bridges - Marathon Industries; 550.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    - d. Mon-Eco Industries, Inc.; 55-50.
    - e. Vimasco Corporation; WC-1/WC-5.
  - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: 60 percent by volume and 66 percent by weight.
  - 5. Color: White.

## 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    - c. Vimasco Corporation; 713 and 714.
  - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
  - 3. Service Temperature Range: 0 to plus 180 deg F.
  - 4. Color: White.

## 2.6 SEALANTS

- A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - b. Eagle Bridges - Marathon Industries; 405.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
  - d. Mon-Eco Industries, Inc.; 44-05.
  - e. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - b. Approved equal
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.7 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
3. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
  - a. Products: Subject to compliance with requirements, provide one of the following:
    - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
    - 2) Approved equal
4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 20 mil thickness; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White.
  4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Metal Jacket:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    - c. RPR Products, Inc.; Insul-Mate.
- E. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film.
    - b. Approved equal

## 2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 491 AWF FSK.

- b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
  - c. Compac Corporation; 110 and 111.
  - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 370 White PVC tape.
    - b. Compac Corporation; 130.
    - c. Venture Tape; 1506 CW NS.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 488 AWF.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - c. Compac Corporation; 120.
    - d. Venture Tape; 3520 CW.
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch in width.

## 2.10 SECUREMENTS

- A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ITW Insulation Systems; Gerrard Strapping and Seals.
    - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. C & F Wire.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

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

#### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

#### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation on pipe systems subsequent to testing and acceptance of tests.
- B. Repair or replace damaged existing insulation as indicated or required.
- C. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Provide continuous insulation through hangers, straps and all other supporting members.
- I. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

- J. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- K. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- L. Install multiple layers of insulation with longitudinal and end seams staggered.
- M. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- N. Keep insulation materials dry during application and finishing.
- O. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- P. Install insulation with least number of joints practical.
- Q. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers.
- R. Install protective metal shields and thermal hanger shield inserts at all supporting members to prevent compression of insulation. Refer to Section "Hangers And Supports For HVAC Piping And Equipment."
- S. Flexible Closed Cell Elastomeric Installation: Slide full sections of insulation onto pipe. Do not slit pipe to fit around piping. All edges shall be clean cut. Insulation shall be pushed onto pipe, never pulled. All seams and butt joints shall be adhered and sealed using adhesive equal to Armaflex 520 Adhesive.
- T. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- U. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- V. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- W. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- X. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- Y. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- Z. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
  2. Testing agency labels and stamps.
  3. Nameplates and data plates.
  4. Manholes.
  5. Handholes.
  6. Cleanouts.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- D. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."



### 3.5 GENERAL PIPE INSULATION INSTALLATION

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

- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

### 3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
  4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
  4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

### 3.7 INSTALLATION OF MINERAL-FIBER INSULATION

#### A. Insulation Installation on Straight Pipes and Tubes:

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

#### B. Insulation Installation on Pipe Flanges:

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

#### C. Insulation Installation on Pipe Fittings and Elbows:

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

#### D. Insulation Installation on Valves and Pipe Specialties:

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

### 3.8 FIELD-APPLIED JACKET INSTALLATION

#### A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- D. Where PVDC jackets are indicated, install as follows:
1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
  2. Wrap factory-presize jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presize jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
  3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
  4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
  5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

### 3.9 FINISHES

- A. Pipe Insulation with ASJ, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

- D. Do not field paint aluminum or stainless-steel jackets.

### 3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.11 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

### 3.12 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.13 INDOOR PIPING INSULATION SCHEDULE

- A. Chilled Water, 40 Deg F and below:
  - 1. NPS 6 and Smaller: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.
  - 2. NPS 8 and Larger: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

- B. Heating-Hot-Water Supply and Return, 90 Deg F to 250 Deg F:
  - 1. NPS 1-1/2 and Smaller: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.
  - 2. Larger than NPS 1-1/2: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.
- D. Piping, Exposed indoors:
  - 1. PVC
- E. Piping, Exposed in Mechanical Rooms, etc...:
  - 1. PVC.

END OF SECTION 23 07 19.00

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL REQUIREMENTS

- A. District Supervisor is a Siemens Talon / Tridium Niagara 4 server furnished, installed, programmed and supported by ASA Controls. The Loveland Middle School is to be seamlessly implemented onto the existing district supervisor incorporating all existing programming, graphics, etc. as developed by ASA Controls / Loveland City Schools.
  - a. All new programming and graphics to conform to standards implemented by ASA Controls and approved by Loveland City Schools.
    - 1) The Owner, Engineer and Commissioning Agent shall make a final determination as to whether all new programming and graphics is consistent with and conform to standards developed for existing controls.
    - 2) The Contractor shall perform, at their expense, any and all programming/graphic rework deemed necessary by Owner, Engineer and/or Commissioning Agent so that new programming and graphics are consistent with and conform to standards developed for existing school controls.
  - b. Contractor to develop detailed sequences of operation for each piece of existing HVAC equipment being provided with upgraded controls under this scope of work. All new sequences to provide level of detail consistent with existing control sequences.
  - c. Owner, Engineer and Commissioning Agent to make final determination as to whether contractor developed sequences, both content and level of detail, are consistent with existing control sequences.
  - d. Contractor will need to perform, at his expense, any and all sequence rework deemed necessary by Owner, Engineer and/or Commissioning Agent so that new sequences are consistent with existing sequences with regards to content and level of detail.
  - e. This scope of work is for control upgrades to existing equipment at the Loveland Middle School.
  - f. This contractor shall furnish and install all incidental controls needed for fully functional controls for the different HVAC equipment listed including but not limited to:
    - 1) Furnishing new control panels, with dedicated 120V power circuits for the new system. Refer to specifications and drawings.
      - a) Refer to sequences of operations.
    - 2) Cat6 cabling between all new Tridium Niagara 4 Jace controllers.
    - 3) Programming, graphics, alarms, schedules and historical trend information for the BAS.

- B. This Building Automation System (BAS) Contractor shall supply and install a complete Siemens Talon / Tridium Niagara 4 BAS with Open License Requirements to accomplish the specified sequences of operation for control of heating, ventilating, air-conditioning and other building equipment and systems as described herein. This BAS shall be fully integrated with the existing ASA Controls District Supervisor. All work in this Section shall be coordinated and provided by a single BAS Contractor. This system in its entirety shall comply with all the networking requirements of a BACnet® system as defined by the latest ASHRAE Standard 135-2016. This includes but is not limited to the following:
  - B. BAS Contractor to provide detailed sequences of operation for each piece of existing HVAC equipment at the Loveland Elementary, Primary and Early Childhood Schools. All new sequences to provide level of detail consistent with existing control sequences.
  - C. Include all power wiring and cabling for the operation of the controls system. Refer to Electrical Division Specifications for additional requirements.

#### 1.1 GENERAL SCOPE OF WORK

- A. Packaged Rooftop Units AH-6 & AH-11 (Qty. 2)
  - a. For bidding information for the below reach out to Brian Agnew @ ASA Controls (513) 310-7942.
  - b. Units to be furnished complete with operating and safety controls for complete stand-alone operation including, but not limited to, all airflow measuring stations, sensors, control devices, etc. per specification section 237433 – Packaged Outdoor Rooftop Units.
  - c. Units to be furnished with BACnet MS/TP (2 conductor RS 485) interface for communication with the DDC system.
  - d. ASA Controls to integrate all applicable points into the DDC system.
  - e. ASA Controls has NO control devices. All airflow measuring stations, sensors, control devices, etc. furnished by others.
- B. Contractor shall implement the Niagara 4 Framework based open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The owner shall be the named license holder of all software associated with any and all incremental work on the project. Only Niagara 4 Framework (with Open License Requirements) are acceptable.
- A. The owner shall receive ownership of all job specific configuration documentation, data files and application-level software developed for the project. This shall include all custom, job specific software code, databases and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for admin and programming level access to any component or software program shall be provided to the owner.



- B. It is the owner's intent to purchase an open system capable of being serviced and expanded by any acceptable system integrator that has and maintains certification (TCP) to work on Niagara Framework systems. The Niagara Compatibility Statement (NICS) for all Niagara Software shall allow open access and be set as follows: `accept.station.in="*" accept.station.out="*" accept.wb.out="*" accept.wb.in="*"`. In any case, the owner shall maintain the right to direct contractor to modify any software license, regardless of supplier, as desired by the owner. The Contractor shall not install any "brand specific" software, applications or utilities on Niagara Framework based devices.
- C. All hardware and field level devices installed, (i.e.; ASCs, PDUs), for the project shall not be limited in their ability to communicate with a specific brand of Niagara Framework device. They shall also be constructed in a modular fashion to permit the next generation and support components to be installed in replace of or in parallel with existing components.
- D. Provide and install all wiring required for a complete system, including communication bus, analog points, digital points, low voltage power, emergency power, and spare communication bus. Splices are not permitted within the IAS FAC LAN or DLN communication cables. Only continuous bus topologies, MS/TP or continuous homeruns are allowed for these networks. Capacity of any bus shall be limited to 80% of the allowable device count to allow for future minor modifications or expansions to the network.
- E. Provision of all documentation called out in these specifications including, but not limited to, submittals, O&M manuals, commissioning submittals, CAD based as-built documentation, and training manuals. Provide both hard copies and electronic files on electronic media.
- F. Training of facility personnel, and or maintenance contractor, on the operation and maintenance of the system.
- G. The repair of all finished surfaces effected as a result of IAS related installation work. This includes but is not limited to carpet, drywall, paint, ceiling tiles, furniture, and the like.
- H. System point to point check out, verification and documentation. Assist the Owner/CxA, and/or TAB Firm in verification and functional performance testing and GUI acceptance testing.
- I. Graphical User Interface Development. The Contractor shall develop the graphics, tools, features, and network integration as required

## 1.2 ACTION SUBMITTALS

- A. The TCC shall not start the project installation until the shop drawing submittals have been reviewed by the Engineer.
- B. Submittals shall include hardware, end devices, ancillary control components, a written operating sequence, unitary control wiring, building floor plans showing communication cabling and labels as well as logic flow diagrams. All submittals shall be provided on paper and electronically in PDF format.
- C. Submittals shall contain one control drawing per specified system and equipment. Drawing shall include point descriptors (DI, DO, AI, AO), addressing, and point names. Each point

names shall be unique (within a system and between systems). For example, the point named for the mixed air temperature for AHU #1, AHU #2, and AHU #3 shall not be MAT but should be named AHU#1MAT, AHU#2MAT, and AHU#3MAT. The point names should be logical and consistent between systems and AHU's. The abbreviation or short hand notation (e.g., MAT) shall be clearly defined in writing by the TCC.

- D. Control diagrams shall identify: System being controlled (attach abbreviated control logic text, all digital points, analog points, virtual points, all functions (logic, math, and control) within control loop, legend for graphical icons or symbols, definition of variables or point names and detailed electric connections to all control devices and sensors.
- E. Points list shall include all physical input/output. Points list shall be provided in both hard copy and in electronic format and shall include: Name, address, engineering units, high and low alarm values and alarm differentials for return to normal condition, default value to be used when the normal controlling value is not reporting, message and alarm reporting as specified, identification of all adjustable points and description of all points.
- F. Submittals shall contain floor plans depicting DDC control devices (control units, network devices, LAN interface devices, and power transformers as well as static pressure sensor in duct and temperature sensors in rooms) in relation to mechanical rooms, HVAC equipment, and building footprint.
- G. Submittals shall contain DDC system architecture diagram indicating schematic location of all control units, workstations, LAN Interface devices, gateways, etc. Indicate address and type for each control unit, Indicate protocol, baud rate, and type of LAN per control unit.
- H. Electrical wiring diagrams shall include motor start, control, and safety circuits and detailed digital interface panel control point termination diagrams with all wire numbers and terminal block numbers identified. Indicate all required electrical wiring. Provide panel termination drawings on separate drawings. Clearly differentiate between portions of wiring that are existing, factory-installed and portions to be field-installed.
- I. Show all electric connections of the controls system to equipment furnished by others complete to terminal points identified with manufacturer's terminal recommendations.
- J. TCC shall provide one complete drawing that shows the control-wiring interface with equipment provided by others.
- K. Submittals shall include project specific graphic screens for each system including a picture of the screen with a list of the variables to be placed on the screen.
- L. Submittals shall include TCC's hardware checkout sheets and test reports.
- M. Submittals shall include the agenda for approval by the engineer and owner of the specified training periods. See training section for requirements.
- N. Provide complete panel drawings that are:
  - 1. Clearly labeled and schematic or drawn to scale.
  - 2. Show the internal and external component arrangement so that the operators can identify the components by their position if the labels come off.

3. Wiring access routes shall also be identified so that Class 1 wiring is separated from Class 2 and 3 and so high voltage wiring is segregated from low voltage wiring.
  4. Complete identification of all control devices (manufacturer's type, number, and function).
  5. Provide details for labeling all wiring, control devices, and controllers.
  6. Material and equipment descriptive material such as catalog cuts, diagrams, performance curves, and other data to demonstrate conformance with specifications shall be provided.
- O. Include room schedule including a separate line for each terminal unit, heat pump, etc. indicating location and address.
- P. Include control valve schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: code number, configuration, fail position, pipe size, valve size, body configuration, close-off pressure, capacity, valve Cv, design pressure, and actuator type.
- Q. Include control damper schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: code number, fail position, damper type, damper operator, duct size, damper size, mounting, and actuator type.

### 1.3 O&M MANUALS AND CLOSEOUT DOCUMENTS

- A. Operating instructions, maintenance procedures, parts and repair manuals shall be supplied. Repair manuals shall include detailed instructions in the setup, calibration, repair and maintenance of all equipment furnished. Also supplied with these manuals will be a complete parts listing of all devices supplied which is to include part numbers and model numbers of all parts and component parts along with exploded views of devices.
- B. All as built drawings (wiring diagrams, flowcharts, floor plans, etc.) shall also be supplied to the owner electronically in PDF format.
- C. System specific wiring, control diagrams, sequence of operation and points lists shall be as installed in each control panel. This means as-built drawings, not design (submittal) drawings.
- D. Supply all software necessary for configuration of, modification, editing or communicating to any of the unitary devices. Software shall be capable of uploading and down-loading the entire unitary data base or any part of the automated system for backup or archiving.
- E. Supply one copy of the software programming manual (hard copy and PDF format). The manual shall describe all furnished software. The manual shall be oriented to programmers and shall describe calling requirements, data exchange requirements, data file requirements, and other information necessary to enable proper integration, loading, testing, and program execution.
- F. Provide a Bill of Materials with each schematic drawing. List all devices/equipment and match to schematic and actual field labeling. Provide quantity, manufacturer, actual product ordering number, description, size, accuracy, operating ranges (voltage, temperature, pressure, etc.), input/output parameters, etc.

- G. Maintenance manual shall include copies of signed-off acceptance test forms, commissioning reports, start-up reports, etc.
- H. The TCC shall turn over to owner two (2) sets of digital back-ups of the complete temperature control system.

#### 1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Include product manufacturers' recommended parts lists for proper product operation over four year period following warranty period. Parts list shall be indicated for each year.

#### 1.5 QUALITY ASSURANCE

- A. DDC System Provider Qualifications:
  - 1. Authorized representative of, and trained by, DDC system manufacturer.
  - 2. In-place facility located within 50 miles of Project.
  - 3. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
  - 4. Demonstrated past experience on 10 projects of similar complexity, scope, and value.
  - 5. Each person assigned to Project shall have demonstrated past experience.
  - 6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
  - 7. Service and maintenance staff assigned to support Project during warranty period.
  - 8. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
  - 9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

#### 1.6 WARRANTY & SOFTWARE LICENSES

- A. Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after substantial completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.
- B. The TCC shall respond to the Owner's request for warranty service within 24 hours during normal business hours. The TCC shall respond to the Owner's request for Emergency service (defined as life-threatening or creating the potential to cause property damage) during the warranty period within 4 hours.
- C. The TCC shall provide technical phone support to the owner during the warranty period for warranty related issues and for two years after the warranty period. If the technical support

location of the TCC is outside of the toll free calling area for the customer, the TCC shall have a toll free number or accept collect calls for the purpose of providing technical support.

- D. During the warranty period, standard parts for the DDC system shall arrive at the facility within 48 hours of placing an order. Non-standard parts (requiring re-manufacturing or ordering from another supplier) shall be shipped within 96 hours.
- E. Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the TCC shall be provided and correctly installed at no charge during the warranty period.
- F. Provide licensed electronic copies of all software for each workstation, laptop, server. This includes, but is not limited to: project graphic images (editing/modifying/creating), project database, trouble-shooting and debugging programs, project-specific programming code and all other software required to operate and modify the programming code (including software at system level, primary control units, secondary control units, and all communication software). Any hardware devices (cables, protection devices) required to operate the software/hardware shall also be provided.
- G. All additional licensing needed for this project shall be supplied by TCC. Software license shall not expire or utilize any sort of protection hardware device for its use. In any case owner shall be free to direct the modification of any software license, regardless of supplier to allow open access to all controllers. Owner shall hold the software and firmware licensing. Software license shall not expire or utilize any sort of protection hardware device for its use.
- H. System software shall be the latest version available with upgrades provided at the end of the warranty period, and shall be fully licensed to the Owner for the entire system. Supply all software necessary for configuration of, modification, editing or communicating to any of the unitary devices. Software shall be capable of uploading and down-loading the entire unitary data base or any part of the automated system for backup or archiving.

## 1.7 TRAINING

- A. A formal on-site "Hands On" training session shall be conducted for the owner's maintenance personnel. This session shall be a minimum of one (1) eight (8) hour days to train the staff on setup, operation, and maintenance of all system(s) and/or devices. This will be at a time and location selected by the owner. One (1) additional eight (8) hour session shall be provided as "opposite season" training – generally 6 months into the warranty period. One (1) additional eight (8) hour session shall be provided at a later date. (This may be requested any time during the warranty period.) All training materials and books shall be provided. Both sessions shall be given by the manufacturers "factory" technical representative. (This is defined as someone other than the installing contractor's representative.) All expenses are to be provided by the TCC. All training sessions shall be scheduled at owner's request.
- B. TCC shall conduct training courses for designated personnel in operation and maintenance of system. Training shall be oriented to specific system being installed under his contract and shall be digitally recorded and submitted on DVD or flash drive by the TCC.

- C. Training shall be a mix of, test exercises, and actual keyboard entry and screen viewing at the operator's terminal. A curriculum shall be discussed and implemented based on the level of expertise of the employees. Hands-on experience and problem solving shall be emphasized.
  - D. If during any training session, the trainer/owner finds more than three (3) items that need repair, the training session will be immediately terminated. The session will be rescheduled for another date. The re-scheduled training session will be carried out at no additional cost to the Owner.
  - E. The training shall be oriented to making the owner self-sufficient in the day-to-day use and operation of the DDC system.
  - F. Additionally, the training shall include:
    - 1. System start-up, shutdowns, power outage and restart routines, alarms, security levels, changing setpoints, changing schedules and other parameters, overrides, freeze protection, manual operation, return to automatic operation, and resetting equipment.
    - 2. All screens shall be discussed, allowing time for questions.
    - 3. Information specifically focused on showing the owner methods of troubleshooting the mechanical systems using the DDC.
    - 4. Use of laptop and hand-held operator interface device, if applicable.
    - 5. Creating, modifying, viewing, downloading, and reloading, trend logs.
    - 6. Remote access to the system.
    - 7. The other training sessions shall be oriented toward answering specific questions from Owner's staff.
    - 8. The trainer must be well grounded in both DDC system operation and in mechanical systems service and shall be the programmer.
  - G. This documentation and process shall be complete, approved and accepted by Engineer and Owner prior to acceptance. This information shall be documented as completed. A copy shall be delivered to the Engineer and Owner and included in the O&M manuals.
- 1.8 COMMISSIONING & VERIFICATION, FUNCTIONAL PERFORMANCE TESTING & CHECKLISTS
- A. 100% compliance with the requirements of this section is a condition of the Owner's acceptance and start of the warranty period.
  - B. The TCC shall be responsible for completion of (1) their hardware checkout sheets and test reports, (2) Point-by-point confirmations of ALL points – this includes visual inspection of installed components, and (3) sequence of operation confirmation.
  - C. This documentation and process shall be complete, approved and accepted by Engineer and Owner prior to acceptance. This information shall be documented as completed. A copy shall be delivered to the Engineer and Owner and included in the O&M manuals. Each subcontractor shall be responsible for completion of their own System Verification Checklists/Manufacturer's Checklists. Sample checklists shall be submitted to the Engineer and Testing Agent for approval.

- D. Air and water balancing shall be completed (and discrepancies resolved) before the TCC's final system check and before the acceptance test to be conducted in the presence of the Engineer.

## PART 2 - PRODUCTS

### 2.1 DDC SYSTEM MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Branch Office is not acceptable):
- B. The following are approved BAS installers:
  - a. ASA Controls
- C. The following are approved BAS component manufacturers:
  - a. Siemens Talon (Siemens Talon Value Added Partner (VAP))

### 2.2 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
  - 1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 2.3 WEB ACCESS

- A. Remote Data Access: The system shall support the Internet Browser-based remote access to the building data. The IAS contractor shall coordinate with the Owner's IT department to insure all remote browser access (if desired by the owner) is protected with the latest Niagara Software updates and a VPN (Virtual Private Network) must be installed to protect the owner's network from cyber-attacks.
- B. Browser-based access: A remote/local user using a standard browser will be able access all control system facilities and graphics via the WAN or direct connection, with proper username and password. Only native Internet browser-based user interfaces (HTML5, Java, XML, CCS3 JAVA Script, etc.) that do not require plug-ins (thin clients) are acceptable. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, Firefox™ or Chrome™.

## 2.4 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E84; testing 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.
- B. DDC System Speed:
1. Response Time of Connected I/O:
    - a. AI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    - b. BI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    - c. AO points connected to DDC system shall begin to respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
    - d. BO point values connected to DDC system shall respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
  2. Display of Connected I/O:
    - a. Analog point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
    - b. Binary point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
    - c. Alarms of analog and digital points connected to DDC system shall be displayed within 45 seconds of activation or change of state.
    - d. Graphic display refresh shall update within eight seconds.
    - e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.
- C. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
- D. DDC System Data Storage:
1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
  2. Local Storage:



- a. Provide server workstation with data storage indicated. Server(s) shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.
3. Cloud Storage:
    - a. Provide application-based and web browser interfaces to configure, upload, download, and manage data, and service plan with storage adequate to store all data for term indicated. Cloud storage shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.
- E. DDC Data Access:
1. When logged into the system, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.
  2. System(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.
- F. Future Expandability:
1. DDC system size shall be expandable to an ultimate capacity of at least two times total I/O points indicated.
  2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
  3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.
- G. Input Point Displayed Accuracy: Input point displayed values shall meet the industry standard end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.
- H. Control Stability: Control variables indicated shall be within the industry standard.
- I. Environmental Conditions for Controllers, Gateways, and Routers:
1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
    - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
  2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures.

J. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
  - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by instrument and application.
2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures.

K. DDC System Reliability:

1. Design, install and configure DDC controllers, gateways, routers, to yield a MTBF of at least 40,000 hours, based on a confidence level of at least 90 percent. MTBF value shall include any failure for any reason to any part of products indicated.
2. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment that are being controlled, operational and under automatic control.
3. Critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated shall be indicated on Drawings.

L. Electric Power Quality:

1. Power-Line Surges:

- a. Protect DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
- b. Do not use fuses for surge protection.
- c. Test protection in the normal mode and in the common mode, using the following two waveforms:

2. Power Conditioning:

- a. Protect DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:
  - 1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
  - 2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
  - 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.

- 4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.
  3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.
- M. Backup Power Source:
1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.
- N. UPS:
1. DDC system products powered by UPS units shall include the following:
    - a. Desktop workstations.
    - b. Printers.
    - c. Servers.
    - d. Gateways.
    - e. DDC controllers, except application-specific controllers.
- O. Continuity of Operation after Electric Power Interruption:
1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

## 2.5 SYSTEM ARCHITECTURE

- A. The system provided shall incorporate hardware and software resources sufficient to meet the functional requirements of these Specifications. The Facility Local Area Network (FAC LAN) and Device Level Network (DLN) shall be based on industry standard open platforms as specified herein and utilize commonly available operation, management and application software. All software packages and databases shall be licensed to the Owner to allow unrestricted maintenance and operation of the BAS. Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.
- B. The system architecture shall implement a new building BAS which is based on the Niagara Framework and consists of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) that supports NCs, PCUs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable.
1. WAN: Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser.

2. Facility Local Area Network (FAC LAN): The FAC LAN shall be an Ethernet-based, 10/100/1000 Ethernet LAN connecting Local NCs, IAS Server and OWSs. The FAC LAN serves as the backbone for the NCs communications path and as the connection point to the WAN. Contractor shall provide a FAC LAN as a dedicated LAN for the control system. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 6 cable with switches and routers that support 1000base-T gigabit Ethernet throughput.
  3. Device Level Network (DLN): Network used to connect PCUs and ASCs. These shall be Peer to Peer devices as defined in the BTL standard.
  4. ARCnet and/or Token-Ring based FAC LANs and DLNs shall not be acceptable.
- C. The communication speed between the controllers, LAN interface devices, CSS, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition.
- D. Niagara Framework Control Systems Server (CSS): A server that maintains the systems configuration and programming database. It shall allow secure multiple-access to the control information.
- E. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server that resides on the FAC LAN. User tools for DLN and FAC LAN management shall be provided and licensed to the Owner and shall allow unrestricted configuring, updating, maintaining, and expanding of all current devices, configurations and settings.
- F. Database Schema shall be published and provided to the Owner to facilitate easy access to DLN and FAC LAN data.

## 2.6 DDC SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:
1. Desktop and portable workstation with hardwired connection through LAN port.
  2. Portable operator workstation with wireless connection through LAN router.
  3. Mobile device and application with secured wireless connection through LAN router or cellular data service.
  4. Remote connection through web access.
- B. Access to system, regardless of operator means used, shall be transparent to operator.
- C. Desktop Workstations:
1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
  2. Able to communicate with any device located on any DDC system LAN.
- D. Mobile Device:

1. Connect to system through a wireless router connected to LAN and cellular data service.
2. Able to communicate with any DDC controller connected to DDC system using a dedicated application and secure web access.

E. Critical Alarm Reporting:

1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
3. DDC system shall notify recipients by any or all means, including e-mail, text message and prerecorded phone message to mobile and landline phone numbers.

F. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

## 2.7 NETWORK COMMUNICATION PROTOCOL

A. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

## 2.8 DESKTOP WORKSTATIONS

A. Description: A tower or all-in-one computer designed for normal use at a single, semi-permanent location.

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

1. Dell Inc.
2. HP.
3. Lenovo.

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.

D. Personal Computer:

1. Operating System: Windows 10 Professional, 64 bit
2. Minimum Processor Speed: 4 GHz.
3. RAM: 8 GB SDRAM @ 1333MHz
4. 1 TB, solid state hard drive
5. 24", 4K LED widescreen, HDMI
6. Video Card: 4K HD Graphics: HDMI
7. Optical Drive: 16X DVD+/-RW with double-layer DVD+/-R write
8. Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector)
9. Wireless Network Support: wireless 802.11 a/b/g/n protocols must be supported
10. Wireless USB Mouse and keyboard
11. Inkjet Printer
12. Surge Protection

2.9 SERVERS

1. Processor: Intel® Xeon® CPU E5-2640 x64 (or better), compatible with dual- and quad-core processors
2. Operating System: Windows 10 64 bit, Windows Server 2016, Red Hat Enterprise
3. Memory: 16 GB minimum
4. Hard Drive: 100 GB minimum, more recommended depending on archiving requirements
5. Display: Video card and monitor capable of displaying 1024 x 768 pixel resolution or greater
6. Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector)
7. Connectivity: Full-time high-speed ISP connection recommended for remote site access (i.e., T1, ADSL, cable modem) and IPv6 compliant.

2.10 WIRE MANAGEMENT, ELECTRICAL POWER, ETC:

- A. Electrical work required for system interlock and installation of the temperature control system shall be included in the bid and installed per all applicable codes. Coordinate with other trades as required for installation of a complete system.
- B. All wiring and cabling in mechanical and electrical rooms shall be in conduit. No wiring or conduit can be exposed to view in any other area. Conceal all wiring and cabling in conduit in wall from thermostats or other controls devices to above ceiling. Install conduit in wall from wall thermostats to above ceiling for cabling. Route wiring directly to cable tray from control points above the ceiling. Rough-in for control devices shall be in compliance with the requirements of the ELECTRICAL SPECIFICATIONS.
- C. If new devices are installed on existing solid walls (i.e. filled block), provide wire mold to hide all surface mounted wiring from view.

- D. Any power for controls shall be fed from dedicated circuits in emergency electrical panels, when provided for a project, and shall not be obtained from receptacles, lighting, or equipment circuits. Unitary control power may be obtained from the equipment served. If power is obtained from the equipment served, the power may not be interrupted to the electronics if the equipment is off for any reason.
- E. The TCC shall be responsible for the power source to any control panels, unitary controllers, etc. on any controlled equipment and all other control power requirements. This includes circuit breakers, wiring, conduit, etc. installed in strict accordance with NEC. The TCC may contract with the electrical contractor for the power wiring installation.
- F. Prior to installation, insure through coordination with all trades, that appropriate clearances (36" minimum) as required by the N.E.C. are maintained at all control panels, including unitary controllers for VAV terminals, heat pumps, etc.
- G. The TCC shall provide all CAT6 cabling network cabling for a complete system. This shall include cabling to the Owner's data drop. The main system data drop will be provided by others.
- H. All control circuits within the electrical panels shall be marked to indicate equipment served.
- I. The TCC shall perform all temperature control interlock wiring. This shall include control valves, dampers, thermostats, indoor/outdoor HVAC systems, etc. Electrical work required for system interlock and installation of the temperature control system shall be included in the bid and installed per all applicable codes. Coordinate with other trades as required for installation of a complete system.
- J. The TCC shall be responsible for any power required for the unitary controls or control panels. This includes circuit breakers, wiring, conduit, etc. installed in strict accordance with NEC. The TCC may contract with the electrical contractor for the power wiring installation.
- K. Provide one duplex outlet mounted inside the control panel and separately fused with a non-time delay fuse at 15 A at any panel location containing electronic control components. This receptacle may be served from the control panel 120 VAC power source.
- L. All wiring shall be continuous runs. Any junctions must be made in metal enclosure.
- M. Grounding terminals shall be color coded green and yellow and shall be compatible with the other specialty terminals specified above and shall mount on the same DIN rail system. Units shall be arranged so that the wiring connected to them is grounded to the enclosure via the mounting rail. These terminals shall be provided for grounding cable shields at the points where the cables enter a control panel and terminate on the control panel terminal strip. Terminals shall be Entrelec M 4/5.3A.PI or equivalent by Weidmuller, Phoenix, or Allen Bradley.
- N. The Department of Housing, Building and Construction's Electrical Division requires that all new lighting control panels, new Building Automation Systems control panels, and new conventional HVAC control panels be certified as being constructed and wired in accordance with NFPA 70 110.3 (a) (1) and article 409.

- O. Contractor shall ensure control panels have an identification label stating the “Certification Agency” such as UL, CSA, CE, etc. or a label of certification for each control panel by a Professional Engineer (P.E.) registered in the State of Kentucky, stating that the design of the control panel was under their direct supervisory control. Include with shop drawings.
- P. The Electrical Advisory Council for the State of Kentucky requires that only an electrical contractor licensed by the State of Kentucky with a licensed Master Electrician and a licensed on-site electrician can install the electrical wiring for lighting controls systems or Building Automation Systems (BAS).

2.11 CABLING:

- A. All control wiring shall be installed in a wire management system to include cable trays, bridge rings, & conduits. No exceptions! Coordinate with electrical contractor to ensure a complete wire management system.
- B. A complete cabling system shall be furnished and installed, which shall adhere to the highest workmanlike standard of quality and appearance. Cabling shall be installed square with building lines and contained within a wire management system.
- C. All sizing of cabling shall be according to manufacturer’s recommendations, but shall be a minimum of 18 AWG.
- D. Furnish a floor plan of the building indicating communication cable labeling and routing as well as addresses and branch wiring from the unitary devices. All cabling shall be labeled on both ends. The type, size and label of all cabling shall be indicated on submittal floor plan drawings.
- E. Wall space temperature sensor cabling (from the sensor to the unitary controller) shall have a minimum of four (4) conductors.
- F. All cabling shall be stranded. "NO" solid conductors will be accepted. All cabling shall be 100% shielded with appropriate drain wire and insulation. System specific, proprietary controls wiring, i.e. VRF/VRV controls wiring, is the only exception.
- G. All cable connections shall be continuous run (including shield). Any junctions must be made in a metal enclosure, connections must be soldered, taped and the metal enclosure must be mechanically attached to the nearest ground. No wire nuts or crimped connections will be accepted. Note location of junction boxes on the as built floor plans. All cabling networking unitary controllers, and other networked equipment, shall be in soldered.
- H. All shields must be terminated as per manufacturer’s recommendation. Shield termination requirements by the manufacturer must be provided with submittals.
- I. Wireless controllers are not approved unless specifically mentioned in the sequence of operations or noted on plans.



## 2.12 SYSTEM SOFTWARE

- A. System software will be the latest version available with upgrades provided for full warranty period, and shall be fully licensed to the owner for all network controllers and servers.
- B. The BAS shall include trend logging screens accessible from tabs on the home page for building utilities usage.
- C. System software shall, at a minimum, provide:
- D. Monitor and supervise all control points.
- E. Add new points and edit system database.
- F. Change control setpoints, timing parameters and loop tuning of PID coefficients in all control loops in all control units.
- G. Enter programmed start/stop schedules.
- H. View alarm and messages.
- I. Modify existing control logic (or sequence of operation) in all control units.
- J. Upload/Download programs, databases, control parameters, etc.
- K. Modify graphic screens.
- L. Sequence of operation programming methodology - The application software shall be user programmable. Application programming shall be (1) Line type programming that uses text programming in a language similar to BASIC or FORTRAN, or (2) graphical block programming - The method of programming shall be by manipulation of graphic icon "blocks." Each block represents a subroutine containing the programming necessary to execute the function of the device that the block represents.
- M. Unitary Control Unit Database Archiving - The host software shall provide capability to upload sequence of operation, database, and other control parameters from each controller. Uploaded programs shall be retained on hard disk for system backup. Programs may be modified using Editor functions, and downloaded to individual controllers as desired. Downloading of databases shall not interrupt other multi-tasked functions that are ongoing.
- N. THIRD PARTY SOFTWARE PACKAGES: The host software shall provide the capacity to run third party software packages for word processing, spreadsheets, or database management programs. Use of third party software shall not suspend operation of background tasks of multi-tasking operating system, such as alarm logging, and report generation.

## 2.13 NETWORK CONTROLLER (Siemens Talon / Tridium N4 Jace)

- A. Install the Network Controller in a surface mounted panel, NEMA type 1 enclosures, with a removable hinged door. Provide a flush mounted key lock. All control panels must be painted

the same color and identified. The boxes are to be made from 16 gauge material. Panels should not be provided with knockouts.

- B. Control panels shall be constructed by a UL approved panel manufacturer. The standard used shall be UL508A. All proper labels are to be attached. Panel shall meet arc flash requirements.
- C. The Network Controller shall be web-based and communicate BACnet IP. It shall issue all time schedules, summer/winter commands, customized trending, holiday scheduling, alarm handling, clock or other shared commands to all unitary controllers within the building network. If for any reason communications between the unitary(s) and the Network Controller is lost, the unitary(s) shall operate in a stand-alone manner (in day operation) until communications is restored. It shall also operate in the “summer” or “winter” mode as last commanded.
- D. The Network Controller shall be integrated and interoperable with the facility infrastructure and include user access to all system data locally over the Local Area Network (LAN) / Wide Area Network (WAN) within the building and remotely by a standard Web Browser over the Internet. Any computer connected to the network, utilizing a web browser and having the proper password.
- E. The Network Controller shall be a fully user-programmable, supervisory controller. It shall monitor the network of distributed unitary controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Controllers.
- F. The Network Controller shall have battery back-up to allow a minimum of seven days of operation. The Network Controller shall be composed of one or more independent, stand-alone, microprocessor to manage the network strategies described in Application software section. The network controller shall have ample memory to support its operating system, database and programming requirements. The operating system of the Network Controller shall manage the input and output communications signals to allow distributed unitary controllers to share real and virtual point information and allow central monitoring and alarms. The database and custom programming routines of the Network Controller shall be editable from a single operator station.
- G. The Network Controller shall be remotely monitored via the internet. Additionally, it shall include automatic emailing and texting out alarms, gathering alarms, reports and logs, programming and downloading database.
- H. The Network Controller shall continually check the status of all processor and memory circuits. If a failure is detected, the controller shall:
  - 1. Assume a predetermined failure mode.
  - 2. Emit an alarm.
  - 3. Display card failure identification.
- I. Under no circumstance shall more than 80% of the total number of sensor and control points be connected through a single Network Controller. Each DDC system component shall provide for the future addition of at least 20% of each type of the number of sensor and control points connected to that component including a minimum of one universal input and one universal output.

2.14 PROGRAMMABLE EQUIPMENT CONTROLLER (Siemens Talon / Tridium N4 Jace)

- A. Unless otherwise specified, the following pieces of equipment shall have their own Siemens Talon / Tridium N4 Jace (i.e., Hot Water System, Chilled Water System, Modular Air Handlers, etc.). The Programmable Equipment Controller shall be mounted in a panel and properly labeled.

2.15 UNITARY CONTROLLER (Siemens Talon DXR)

- A. Unless otherwise specified, each piece of equipment shall have its own Unitary Controller (i.e., rooftop unit, VAV Box, Fan coil unit, unit ventilator, terminal unit, etc.). The Unitary Controller for each piece of equipment shall be mounted on the side of the unit. The Unitary Controller for all other equipment shall be mounted in a panel and properly labeled.
- B. Unitary Controllers used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F. All Unitary Controllers shall have an RJ-11 or similar type connection for monitoring or programming access by room or local equipment level with access to any unitary within the network without modification.
- C. Control panels shall be constructed by a UL approved panel manufacturer. The standard used shall be UL508A. All proper labels are to be attached. Panel shall meet arc flash requirements.
- D. Unitary Controllers utilized in the network shall have full standalone capability including time of day and holiday scheduling as well as all energy management functions such as optimal start/stop, duty cycling, etc. The terminal unit Unitary Controllers may be pre-programmed with the project specific sequence of operation as specified for the application. Any re-programming of the electronics shall be performed on location using a portable personal computer with appropriate software or through the Network Controller. The entire unitary data base shall have the capability of being backed up and or downloaded locally.
- E. All points to have a unique digital input to the BAS system. The use of digital point count expanders is not an acceptable replacement to digital inputs to the unitary controller. The conversion of a single universal input channel to accept up to multiple voltage free contacts such as relay contacts, auxiliary starter contacts, differential pressure switches, etc. IS NOT ACCEPTABLE.
- F. Unitary Controllers shall communicate via BACnet MSTP communication protocol. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each Unitary Controller that will communicate on the BACnet MS/TP Bus.
- G. All Unitary Controllers shall be fully application programmable. All control sequences within or programmed into the unitary controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery shall be retained.
- H. Unitary Controllers shall have a 20% spare point capacity to be provided for all applications.
- I. The Unitary Controller for each VAV box shall be mounted on the side of the unit. The unitary controller for all other equipment shall be mounted in a panel and properly labeled. Prior to installation, ensure through coordination with all trades, that appropriate clearances (36"

minimum) as required by the N.E.C. are maintained at all control panels, including unitary controllers for VAV terminals, etc.

- J. After a power failure, the Unitary Controller shall operate the control application using the current setpoints and configuration. Reverting to default or factory setpoints are not acceptable.

## 2.16 GRAPHICS SCREENS AND TRENDS

- A. All graphics screens shall be submitted for review by Engineer. Provide the following animated, color graphics screens at a minimum.
1. Entire floor plan home screen with OAT, Time and Date displays.
    - a. Floor plan showing major zones.
    - b. Click major zone displays enlarged floor plan of the zone showing individual system zones & numbers. Include link to respective mechanical room.
    - c. Click individual zone shows system graphic. Display all data points from points list, occ/unocc schedule and setpoints, VAV cfm and setpoint, OAT, Time and Date.
  2. Color Graphic Screens shall be designed for all mechanical systems and shall include the following:
    - a. A graphic shall be the starting page with the building graphically indicated. Break up the floor plan into zones to match Contract Documents. The building shall be the point of reference to enter into the respective building control system.
    - b. All system units including pumps, filters, humidifiers, associated VAV boxes, etc.
    - c. All terminal equipment including but not limited to VAV boxes, reheat coils, zone dampers, etc.
    - d. All OA units.
    - e. Domestic hot water heaters and pumps.
    - f. The summation of all supply OA for each unit shall be displayed on the AHU graphic pages.
    - g. All floor plans indicating all actual room numbers, thermostats and mechanical equipment. Operator shall be capable of clicking on any equipment and pull up the respective graphic screen.
- B. Graphics to include floor plans with room numbers (as-built room numbers) and thermostat locations, links to flow diagrams for all equipment, domestic hot water, and lighting controls.
- C. All new graphics shall match the existing system graphics, unless noted otherwise.
- D. The graphical programming software shall allow for interactive mouse-driven placement of block icons on the graphic screen and connection of block inputs to block outputs by means of drawing lines to form a graphic logic diagram. The user shall not have to manually input text to assign block input/output interconnections. Blocks shall allow entry of adjustable settings and parameters via pop-up windows.

- E. The clarity of sequence shall be such that the user has the ability to verify that the system programming meets the specs without having to learn or interpret a manufacturer's unique programming language. Provide a means for testing and/or debugging the control programs off-line (not communicating with control units) using operator entered values for physical inputs and time. Provide a means for testing and/or debugging the control programs on-line (communicating with control units), showing actual physical inputs and all block outputs in real time.
- F. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time output values.
- G. All graphic software shall be in the HTML web browser format and support multiple simultaneous screens to be opened and resizable in a "Windows" type environment. All functions, except text entry, shall be executable with a mouse. Graphic software shall provide for multitasking such that third party programs can be used while the Operator Workstation Software is on-line. Provide the ability to alarm graphically even when operator is in another software package. The software shall allow for Owner to create user defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics.
- H. The contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, coils, filters, dampers, etc.), mechanical system components (e.g., pumps, heat pumps, etc.), complete mechanical systems (e.g. VAV, etc.) and electrical symbols.
- I. The graphic development package shall use a mouse or similar pointing device to allow the user to perform the following:
  - 1. Define symbols
  - 2. Position items on graphic screens
  - 3. Attach physical or virtual points to a graphic
  - 4. Define background screens
  - 5. Define connecting lines and curves
  - 6. Locate, orient and size descriptive text
  - 7. Define and display colors for all elements
  - 8. Establish correlation between symbols or text and associated system points or other displays.
  - 9. Create hot spots or link triggers to other graphic displays or other functions in the software
- J. The TCC shall including programming of 25-point trends as directed by the Engineer. These can be requested at any time during the project including the warranty period. Trend "change of state" for digital inputs. Trend analog points in 30-minute increments. Maintain trend history for 30 days. Include the following:
  - 1. Outside air temperature
  - 2. OA unit leaving air temperatures for each unit
  - 3. Summation of all VAV boxes connected to a unit
  - 4. VFD speeds (OA & EA)
  - 5. Freezer/Cooler temperatures

6. Makeup water flow rate
7. Electrical power kW and kWh
8. Others as directed in the field

## 2.17 ASHRAE 135 GATEWAYS

- A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable.
- B. Include gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment, only when specifically requested and approved by Owner.
- C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.
- D. Gateway Minimum Requirements:
  1. Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.
  2. Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.
  3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.
  4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.
  5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
  6. Backup programming and parameters on digital media and the ability to modify, download, backup, and restore gateway configuration.

## 2.18 SENSORS AND MISCELLANEOUS DEVICES:

- A. WEATHER STATION HOUSING: Provide Kele Model A21 Outdoor Aspirated Humidity/Temperature housing. NEMA 3R enclosure is painted white to reduce the effect of radiation, and the enclosure has a lockable latch for security. The outdoor air sensor will be installed on the north wall in the shade as not to be effected by sunlight, building ventilation or weather. This location shall be indicated on the control drawings. Installation in outside air ductwork or louvers is not acceptable. If not installed to provide "accurate" temperature readings, it shall be relocated (at the TCC's expense) until a suitable location is found.
- B. SENSOR RESOLUTION: All temperature sensors shall have a minimum resolution of 1/10th of 1 degree F. (0.1 degree F.) Sensor stability shall be 0.24 degrees over a year period. Space sensors shall be tested and accurate to within 0.75 degrees F. Outside air, water and duct sensors shall be tested and accurate to within 2.0 degrees F.

- C. SPACE SENSORS AND THERMOSTATS:
1. Refer to the drawings for proper type and location.
  2. All thermostat and sensors shall be provided with temperature indication, unless otherwise noted.
  3. Programmed set-point shall be locally adjustable limited to 2 degrees above set-point and 2 degrees below set-point for supervised areas.
  4. Unsupervised areas shall have non-adjustable set-point.
  5. Generally, thermostats/sensors shall be installed 5'-0" above the finished floor.
  6. Where thermostats/sensors are to be mounted next to a light switch, install at the same height as the light switch.
  7. Sensors in hallways, vestibules, stairways, restrooms and locker rooms shall utilize a stainless steel surface mount temperature sensor installed on an interior wall or partition (2"x4" blank plate). Care must be taken in the installation of these sensors to ensure proper insulation from the wall temperatures in order to properly sense space temperature.
  8. If there is a question consult engineer prior to rough-in.
- D. WATER SENSORS: Temperature sensors for water lines are to be the well type. Wells are to be threaded brass (same manufacturer as the temperature sensor) with the sensor coated with a heat transfer compound. Strap on sensors will not be acceptable.
- E. MIXED AIR SENSORS: These sensors shall be bendable averaging, type made of copper or aluminum elements. In unit ventilators, these sensors shall be at least five (5) feet in length and installed in the discharge air of the unit. For Air Handling Units, Outside Air Units, etc. the sensors shall be at least 20 feet in length.
- F. DISCHARGE AIR AND DUCT ROOM RETURN AIR SENSORS: Shall be rigid insertion type. In all applications, care shall be taken to ensure that the sensors are securely mounted as not to allow any vibration and installed in such a manner as to indicate the truest possible temperature.
- G. FREEZE/LOW-LIMIT THERMOSTAT: Provide a freeze/low-limit thermostat in each Air Handling Unit, Outside Air Unit, etc with a water coil for freeze protection. These devices shall be the manual reset type. This device shall be wired by using a normally closed contact in series with the motor starting circuit and a normally open set of contacts as an input to the unitary controller. The element shall be constructed of copper and be at least 20 feet in length. It shall be installed serpentine across the air entering the coil. In some cases it may require being installed after the coil. Each application should be closely evaluated before installation. The device shall sense the lowest temperature by any one foot section of its element.
- H. HUMIDITY SENSORS: These devices shall be 100% solid state, linear and temperature compensated with scaling 0-100% RH range with LED or LCD Display. Accuracy at 25°C from 10-80% RH\*  $\pm 2\%$ , operating Humidity Range 0 to 100% RH (non-condensing), Stability  $\pm 1\%$  @ 20°C (68°F) annually, for two years, Hysteresis 1.5% typical, Temperature Effect  $\pm 0.1\%$  RH/°C above or below 25°C (typical), 1% accuracy between 0% - 90% RH, Operating Temperature Range -40° to 50°C (-40° to 122°F)  $\pm 1\%$ .-Do not submit products that do not meet this range. The output of the device shall utilize an analog output 4-20 mA, 2-wire, polarity insensitive, (clipped and capped), The device shall use a power supply of 24 VAC or VDC. Duct mounted sensors shall have at least 4" insertion probe with a 16 gauge steel enclosure. NIST traceable certification shall be provided to the Engineer as part of the shop

drawings. For wall mounted sensors the enclosure shall be polystyrene plastic mounted next to and at the same height as the temperature sensor in that area. Both shall have the same appearance. Provide protective cages in fitness and common areas.

- I. **COMBINATION TEMPERATURE/HUMIDITY SENSORS:** All temperature sensors shall have a minimum resolution of 1/10th of 1 degree F. (0.1 degree F.) Sensor stability shall be 0.24 degrees over a year period. Space sensors shall be tested and accurate to within 0.75 degrees F. The humidity sensing device shall be 100% solid state, linear and temperature compensated with a 0-100% RH range. The response time shall be a minimum of 30 seconds for a 60% change. They shall have a minimum of 2% accuracy minimum accuracy of +/-2% RH minimum rangeability 5 to 95% RH non-condensing and maximum hysteresis +/-1.5% RH. Do not submit products that do not meet this range. The output of the device must utilize a 0-10 VDC or 4-20mA signal as required. The device must use a power supply of 24 VAC or VDC. Duct mounted sensors shall have at least 4" insertion probe with a 16 gauge steel enclosure. NIST traceable certification shall be provided to the Engineer as part of the shop drawings. For wall mounted sensors the enclosure shall be polystyrene plastic mounted next to and at the same height as the temperature sensor in that area. Both shall have the same appearance. Provide protective cages in fitness and common areas.
- J. **LOW PRESSURE TRANSDUCERS:** These devices shall be 100% solid state, linear and temperature compensated. Accuracy shall be no less than plus or minus 1% of its full range. Linearity, repeatability and hysteresis shall be no less than plus or minus 0.1%. All pressure sensors shall utilize output averaging/output clipping to adjust and stabilize any fluctuations in the output. The output of the device shall utilize a 0 - 10 VDC signal. The device shall use a power supply of 24 VAC or VDC. The enclosure 16 gauge steel. For sensing internal static pressure of air handling ducts utilize sensors with a range of 0 to 5 inches water column. For sensing building static pressures (building compared to atmospheric) utilize a sensor with a range of -0.25 to +0.25 inches water column.
- K. **RELAYS:** Relays for starting and stopping fractional horsepower motors shall be rated as follows:
1. 1/4 horsepower motors or less use 15 ampere rated relays,
  2. 1/3 horsepower motors use 20 ampere rated relays,
  3. 1/2 horsepower motors use 30 ampere rated relays,
  4. Relays used for pilot duty service shall be rated at a minimum of 10 amperes.
  5. Provide auxiliary pilot duty relays on motor starters as required for control function.
  6. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
- L. **CENTRAL STATION AIR HANDLERS:** All Central Station Air Handlers, Outside Air Units, etc shall be provided with a D.A.P. (differential air pressure) switch across each the supply fan to provide fan status for each air handler.
- M. **SMOKE SHUTDOWN:** All AHUs, OA units, Heat Pump Units, etc with fans of greater than 2,000 CFM are required to have smoke shutdown safeties as required by the Building Code. These smoke detectors shall have a set of auxiliary contracts wired to a dedicated input of the Unitary to provide status of the smoke detector. All units must be provided with a current sensor to provide fan status for each air handler. For projects with Outside Air (OA) units, any system fire alarm activation shall shutdown all OA units. Coordinate with the Fire Alarm Contractor to ensure a complete, code compliant installation.



- N. CURRENT SENSING DEVICES: Veris Industries model Hx08 Series and H701 or equal. All current sensors shall be capable of alarming to the BAS for belt losses, pump coupling shear or other mechanical failure on loads.
- O. DIFFERENTIAL PRESSURE TRANSMITTERS: Provide Rosemount (ITT Bell & Gossett ST-102R) or Johnson Controls Setra DPT 2302-050-V field mounted differential pressure sensor transmitters as indicated on the plans. Range shall be 0-25 psig. Accuracy shall be .025% full span.
- P. CARBON DIOXIDE SENSORS: This sensor shall have a range of 0-2000 ppm +/-5% and +/-50 ppm. Analog output of 0-10 or 2-10 VDC. Power shall be 24VAC. Calibration interval rated for 5 years. Sensor shall not be provided with a digital display. Honeywell Model C7232 or equal. A replacement CO2 sensor shall be installed annually for 5 years after substantial completion by the controls contractor. Provide with LED display.

## 2.19 VALVES

- A. Unless otherwise specified, valves shall be furnished and sized by the TCC. The valves are to provide the required capacity and the close off rating shall be in excess of the system pressures encountered (minimum 40 psi differential). Proportioning-type valve bodies shall be packed type with throttling type inner valve (quick close plug shall not be acceptable). Proportional type valves to be rated at 125 psi static pressure. Two position control valves (open/close) shall be line size.
  - 1. Fail positions unless otherwise indicated:
    - a. Chilled Water: Close
    - b. Heating Hot Water: Open
- B. Control valve shutoff classifications shall be FCI 70-2, Class IV or better unless otherwise indicated.
- C. Valve pattern, three-way or straight through, shall be as indicated on Drawings.
- D. Modulating straight-through pattern control valves shall have equal percentage flow-throttling characteristics unless otherwise indicated.
- E. Modulating three-way pattern water valves shall have linear flow-throttling characteristics. The total flow through the valve shall remain constant regardless of the valve's position.
- F. Modulating butterfly valves shall have linear flow-throttling characteristics.
- G. Globe-type control valves shall pass the design flow required with not more than 95 percent of stem lift unless otherwise indicated.
- H. Rotary-type control valves, such as ball and butterfly valves, shall have Cv falling between 65 and 75 degrees of valve full open position and minimum valve Cv between 15 and 25 percent of open position.
- I. Selection shall consider viscosity, flashing, and cavitation corrections.

- J. Valves shall have stable operation throughout full range of operation, from design to minimum Cv.
- K. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
- L. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 5 psig at design flow unless otherwise indicated.
- M. Modulating valve sizes for steam service shall provide a pressure drop at design flow equal to lesser of the following:
  - 1. 50 percent of the valve inlet pressure.
  - 2. 50 percent of the absolute steam pressure at the valve inlet.
- N. In water systems, use ball- or globe-style control valves for two-position control for valves NPS 2 and smaller and butterfly style for valves larger than NPS 2.
- O. "ALL" Actuators shall be of the same manufacturer and have internal feedback circuitry to provide a positive action to ensure proper positioning of the valve through the entire sequence. Actuators shall have an adjustable starting point to accurately set the range of travel to the output of the controller. All actuators shall also utilize the same input signal (6-9 VDC, 0-010V, 2-10 VDC, 4-20 MA) in order to maintain some consistency in the control application. Analog actuation is 6-9 VDC, 0-010V, 2-10 VDC or 4-20 MA, floating point control with 2 digital outputs is NOT approved as analog actuation.
- P. Actuators may be factory installed. If not factory installed they shall be installed as per instructions by the terminal equipment manufacturer.
- Q. Locations mounted above ceiling shall be marked on ceiling grid.

## 2.20 DAMPERS

- A. Dampers for various units requiring field mounting shall be tight closing, "ultra-low leakage", opposed blade with side and edge seals. They shall be sized and furnished under this section. Installation of dampers shall be by the sheet metal contractor, coordinated by the TCC. Frames shall be no less than 16 gauge galvanized steel and furnished with mounting holes for duct mounting. Damper blades shall be no less than 14 gauge galvanized steel with maximum blade width of 8 inches. Blades shall be secured to 1/2 inch zinc plated axles and hardware with nylon bearings. Provide thrust bearings at the end of each blade. All dampers shall have end switches to positively prove damper position. No Exceptions!
- B. All damper actuators shall be fail safe spring return type with sufficient force to operate the dampers or valves under all normal operating conditions. They shall return to the normally open position upon a loss of power.
- C. "ALL" Actuators shall be of the same manufacturer and have internal feedback circuitry to provide a positive action to ensure proper positioning of the damper through the entire sequence. Actuators shall have an adjustable starting point to accurately set the range of travel to the output of the controller. All actuators shall also utilize the same input signal (6-9 VDC, 0-

010V, 2-10 VDC, 4-20 MA) in order to maintain some consistency in the control application. Analog actuation is 6-9 VDC, 0-010V, 2-10 VDC or 4-20 MA, floating point control with 2 digital outputs is NOT approved as analog actuation.

- D. Actuators may be factory installed. If not factory installed they shall be installed as per instructions by the equipment manufacturer.
- E. Locations mounted above ceiling shall be marked on ceiling grid.
- F. Install damper motors on the outside of the duct in warm areas where possible, not in air stream or locations exposed to outdoor conditions.

#### AIRFLOW MEASURING DEVICE (AMD)

#### G. GENERAL REQUIREMENTS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ebtron
  - b. Ruskin
  - c. Greenheck
2. Provide one thermal airflow measuring device for each location indicated on plans, schedules and/or control diagrams. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.
3. Each AMD shall use the principle of thermal dispersion to determine the actual or mass airflow rate of the airstream. Differential pressure-based devices, including pitot tubes, pitot arrays, piezo-rings and devices measuring the pressure drop across a louver, damper or obstruction are not acceptable.
4. Each AMD shall be provided with one or more sensor probes having one or more sensor nodes per probe.
5. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. The airflow of each sensor node shall be determined using one self-heated and ambient temperature sensing thermistor. Devices using indirectly heated thermistors to determine the airflow rate are not acceptable. Devices using chip thermistors of any type or packaging are not acceptable. Devices using platinum wire RTDs or similar "hot wire" devices are not acceptable.
6. Thermistors shall be potted in an engineering thermoplastic assembly using water-proof, marine epoxy and shall not be damaged by moisture, direct contact with water or exposure to atmospheric acids. Provide a copy of an independent laboratory report to verify compliance with this requirement.
7. All internal wiring in the probe tube shall be chemical and abrasion resistant Kynar® coated copper.
8. All connections to internal wires in the probe tube shall be solder joints or welds. Connectors of any type in the probe tube are not acceptable.
9. Each thermistor shall be independently calibrated to NIST traceable temperature standards to establish the resistance-temperature characteristics for the determination of airflow and temperature. Devices using interchangeable, curve-matched, thermistors are not acceptable.
10. The airflow sensing thermistor of each sensor node shall be self-heated. Devices using indirectly heated thermistors are not acceptable.

11. Each sensor node shall be independently processed by the transmitter prior to averaging and output.
12. The specified sensor accuracy shall include the combined uncertainty of the sensor nodes and transmitter. Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with the specified sensor accuracy over the entire operating range.
13. Installed accuracy shall include the uncertainty of the AMD and the additional uncertainty that results from the placement of the AMD in the airstream. The specified installed accuracy is based on the AMD being installed in accordance with manufacturer's published placement and installation guidelines.
14. Transmitters shall be microprocessor-based and operate automatically after brownouts and/or transient power interruptions.
15. All printed circuit boards shall have gold plated interconnects, edge fingers, and test points.
16. Remote transmitters shall have an LCD and four-button user interface.
17. Remote transmitters shall be mounted in a location protected from moisture, rain and snow with an ambient temperature between -20 and 120 °F and a humidity range between 5 and 95% RH (non-condensing). Provide a weatherproof enclosure and mount away from direct sunlight when outdoor mounting is required.
18. Probes with remote transmitters shall be "plug and play", not require matching to the transmitter, and be provided with a UL listed, FEP jacketed, plenum rated cable and connector plug. Devices using PVC jacketed cables to connect sensor probes to the transmitter are not acceptable.
19. All components of each AMD shall be RoHS2 compliant.
20. Each AMD shall be UL/cUL listed as a final assembly.
21. Each AMD shall be FCC-Part 15 compliant. Compliance shall be demonstrated by an independent test laboratory.
22. European shipments shall be CE marked. Compliance shall be demonstrated by an independent test laboratory.
23. Devices with a BACnet network connection shall be BTL tested and listed.

H. DUCT AND PLENUM AMD WITH TEMPERATURE AND HUMIDITY MEASUREMENT AND REMOTE TRANSMITTER

1. Each AMD shall be suitable for installation in ducts and plenums; including air handling equipment cabinets and outdoor air intakes to determine the airflow rate, velocity weighted temperature and humidity of the airstream. Enthalpy and dewpoint shall be calculated using the velocity weighted temperature, humidity and on-board pressure sensor.
2. Provide one to four gold anodized 6063 aluminum probes and one remote transmitter. Probes shall have integral 304 stainless steel mounting brackets for insertion, internal or standoff mounting. Probe connector plug and receptacle pins shall be gold plated.
3. Each sensor node shall be individually wind-tunnel calibrated at 16 points to NIST traceable airflow standards and have an accuracy of  $\pm 2\%$  of reading over the entire operating range. Provide a copy of the NIST calibration report for the reference standard used to calibrate the production tunnels used to calibrate individual sensor nodes. Reference standards calibrated to third-party NIST traceable labs are not acceptable. Devices claiming AMCA certification are not acceptable.
4. Provide up to 16 sensing nodes per measurement location as required for the opening size and published sensor density tables to achieve an installed airflow accuracy of  $\pm 3\%$  of reading ( $\pm 5\%$  of reading on close coupled outdoor air intakes) between 0 and 5,000 fpm

over a temperature range of -20 to 160 °F and a humidity range between 0 and 100% RH (non-condensing). Provide the velocity weighted temperature of the airstream with an accuracy of  $\pm 0.15$  °F.

5. This product may be used to for temperature measurement when the required measurement location for temperature is satisfied by the measurement location of the AMD.
6. Provide humidity measurement of the airstream with the following accuracy at 77 °F:
  - a.  $\pm 2\%$  of reading between 20 and 80% RH.
  - b. Better than  $\pm 4\%$  of reading at all other % RH at 77 °F.
7. The humidity sensor shall have a temperature coefficient of 0.07% RH/ °F and the annual drift shall not exceed 0.5% RH/year.
8. This product may be used for humidity, enthalpy or dewpoint when the required measurement location for humidity, enthalpy or dewpoint can be satisfied by the measurement location of the AMD.
9. Provide low and high airflow alarms with a user defined setpoint and tolerance. The airflow rate, temperature, humidity, enthalpy or dewpoint, airflow alarm and system status alarm shall be visible on the transmitters display.
10. Transmitters with analog output signals shall provide:
  - a. One linear output signal for airflow.
  - b. One linear output signal for velocity weighted temperature or one binary signal for the airflow alarm or system status alarm.
11. Transmitters with network capability shall provide the airflow, velocity weighted temperature, humidity, enthalpy, dewpoint, airflow alarm status, individual sensor node airflow and temperature data and device fault status.

#### 2.21 DC POWER SUPPLY

1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
2. Enclose circuitry in a housing.
3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
4. Performance:
  - a. Output voltage nominally 25-V dc within 5 percent.
  - b. Output current up to 100 mA.
  - c. Input voltage nominally 120-V ac, 60 Hz.
  - d. Load regulation within 0.5 percent from zero- to 100-mA load.
  - e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
  - f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

#### 2.22 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS FOR WORKSTATIONS

- A. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
- B. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
  1. Larger-capacity units shall be provided for systems with larger connected loads.

2. UPS shall provide 20 minutes of battery power.

C. Performance:

1. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
2. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
3. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152-V ac.
4. On Battery Output Voltage: Sine wave.
5. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
6. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
7. Transfer Time: 6 ms.
8. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.

D. UPS shall be automatic during fault or overload conditions.

E. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.

F. Include front panel with power switch and visual indication of power, battery, fault and temperature.

G. Unit shall include an audible alarm of faults and front panel silence feature.

H. Unit with four NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.

I. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure) and connect the points to the DDC system.

J. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.

K. Include tower models installed in ventilated cabinets to the particular installation location.

## 2.23 ACCESSORIES

A. Pressure Electric Switches:

1. Diaphragm-operated snap acting switch.
2. Set point adjustable from 3 to 20 psig.
3. Differential adjustable from 2 to 6 psig.
4. Rated for resistance loads at 120-V ac.
5. Body and switch housing shall be metal.

B. Damper Blade Limit Switches:

1. Sense positive open and/or closed position of the damper blades.
2. NEMA 250, Type 13, oil-tight construction.
3. Arrange for the mounting application.

4. Additional waterproof enclosure when required by its environment.
5. Arrange to prevent "over-center" operation.

C. Instrument Enclosures:

1. Include instrument enclosure for secondary protection to comply with requirements indicated in "Performance Requirements" Article.
2. NRTL listed and labeled to UL 50.
3. Sized to include at least 25 percent spare area on subpanel.
4. Instrument(s) mounted within enclosure on internal subpanel(s).
5. Enclosure face with engraved, laminated phenolic nameplate for each instrument within enclosure.
6. Enclosures housing pneumatic instruments shall include main pressure gauge and a branch pressure gauge for each pneumatic device, installed inside.
7. Enclosures housing multiple instruments shall route tubing and wiring within enclosure in a raceway having a continuous removable cover.
8. Enclosures larger than 12 inches shall have a hinged full-size face cover.
9. Equip enclosure with lock and common key.

D. Manual Valves:

1. Ball Type:
  - a. Body: Bronze ASTM B62 or ASTM B61.
  - b. Ball: Type 316 stainless steel.
  - c. Stem: Type 316 stainless steel.
  - d. Seats: Reinforced PTFE.
  - e. Packing Ring: Reinforced PTFE.
  - f. Lever: Stainless steel with a vinyl grip.
  - g. 600 WOG.
  - h. Threaded end connections.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
  1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
  2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."
- H. Welding Requirements:
  - 1. Restrict welding and burning to supports and bracing.
  - 2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
  - 3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
  - 4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.
- I. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.



2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.

- J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

### 3.4 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests and calibration.

- B. Check instruments for proper location and accessibility.

- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.

- E. Control Damper Checkout:

1. For pneumatic dampers, verify that pressure gauges are provided in each air line to damper actuator and positioner.
2. Verify that control dampers are installed correctly for flow direction.
3. Verify that proper blade alignment, either parallel or opposed, has been provided.
4. Verify that damper frame attachment is properly secured and sealed.
5. Verify that damper actuator and linkage attachment is secure.
6. Verify that actuator wiring is complete, enclosed and connected to correct power source.
7. Verify that damper blade travel is unobstructed.

- F. Control Valve Checkout:

1. For pneumatic valves, verify that pressure gauges are provided in each air line to valve actuator and positioner.
2. Verify that control valves are installed correctly for flow direction.
3. Verify that valve body attachment is properly secured and sealed.
4. Verify that valve actuator and linkage attachment is secure.
5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
6. Verify that valve ball, disc or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

- G. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
2. Verify that attachment is properly secured and sealed.

3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments:
  - a. Verify sensing element type and proper material.
  - b. Verify length and insertion.

3.5 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
  1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
  2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
  3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

K. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

L. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

### 3.6 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.

5. If applicable, verify if connected to a backup power source.
  6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.
- B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.
- C. Verify that spare I/O capacity is provided.

END OF SECTION 230923

## SECTION 232113 – ABOVE GROUND HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Pipe and tube.
  - 2. Fittings.
  - 3. Joining materials.
  - 4. Transition fittings.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

#### 1.4 GENERAL REQUIREMENTS

- A. Unless otherwise indicated, all materials shall be new and of the best grade and quality for the type specified. Materials shall comply with the “Buy American Act”.
- B. Where piping is not indicated on the plans, but is obviously or apparently required, contact the Engineer prior to submission of the bid.
- C. All piping shall be capped or plugged during erection as required to keep clean and debris and moisture free.
- D. The piping indicated shall be installed complete and shall be of the size indicated. When a pipe size is not indicated, the Contractor shall request the pipe size from the Engineer. Where a section of piping is not indicated but is obviously required for completion of the system, the Contractor shall provide same at no additional cost to the project.
- E. Piping shall be installed so as to allow for expansion without damage to the building finishes, structure, pipe, equipment, etc., use offsets, U-bends or expansion joints as required. No mitered joints or field fabricated pipe bends shall be accepted. Pipe shall clear all windows, doors, louvers and other building openings.

- F. Insulated piping shall be supported on a rigid insulation block at each hanger so as to prevent crushing of insulation by hangers. Hangers shall pass completely around the insulation jacket and a steel protective saddle shall be applied to prevent compression of the insulation.
- G. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes shall not be permitted.
- H. In metal buildings or buildings with light gauge trusses, support piping with standard pipe hangers with C-clamp connection to main structural members (not perlins), use angle steel cross pieces between main structural members where required to provide rigid support.
- I. Where piping rests directly on a hanger, clip, bracket or other means of support, the support element shall be of the same material as the pipe, (e.g., copper to copper, ferrous to ferrous, etc.) or shall be electrically isolated one from the other so as to prevent pipe damage by electrolysis. Pay particular attention and do not allow copper pipe to rest on ferrous structural members, equipment, etc. without electrolytic isolation. This includes temporary support required during Construction.
- J. Pipe shall be cut accurately to measurements established at the building by the Contractor and worked into place without springing or forcing. All pipes shall be reamed to full pipe diameter before joining and before assembling. All lengths of pipe shall be set vertically and tapped with a hammer to remove scale and dust and inspected to insure that no foreign matter is lodged therein.
- K. All hot and cold water piping shall be kept a sufficient distance apart so as to prevent heat transfer between them. Cold water piping shall also be kept apart from refrigerant hot gas lines.
- L. Piping carrying water or other fluids subject to freezing shall not be installed in locations subject to freezing without a means of freeze protection. If in doubt, consult Engineer.
- M. Pay particular attention to conflict of piping with other work. Do not install until conflict is resolved. If in doubt, consult Engineer.
- N. Piping materials in each system shall, to the extent practicable, be of the same material. Frequent changes of material (for example, from copper to steel) shall be avoided and in no case shall be accomplished without use of insulating unions and permission of the Engineers.
- O. Nipples shall be of the same material, composition and weight classification as pipe with which installed.
- P. When connecting to an existing hydronic water system (chilled, hot, geothermal, etc.) or domestic water system, the Contractor shall include cost to drain the existing piping system and refill with water/closed loop chemicals to match existing fluid. If the building is occupied, and the drain down will affect services to these occupied areas, then the systems shall be drained and refilled over a weekend at a time acceptable to the Owner.
- Q. Tee connections for welded pipe shall be assembled with welding fittings. Where the size of the side outlet is such that a different connection technique than on the run is required, a weld-o-let, sock-o-let, or thread-o-let type fitting may be used for the branch in place of reducing tees only where the branch is 2/3 the run size or smaller. Weld-o-let and thread-o-let branch connections are acceptable.

## 1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
  - 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

## PART 2 - PRODUCTS

### 2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube (Hard Copper): ASTM B88, Type L, and ASTM B88, Type M
- B. Annealed-Temper Copper Tube (Soft Copper): ASTM B88, Type L
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- G. Wrought Copper Unions: ASME B16.22.
- H. Copper-Tube, Pressure-Seal-Joint Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Elkhart Products Corporation.
    - b. Mueller Industries, Inc.
    - c. NIBCO INC.
    - d. Viega LLC.
  - 2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
  - 3. Minimum 200-psig working-pressure rating at 250 deg F.

## 2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.
- C. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.
- D. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

## 2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

## 2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings:
  - 1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.
- B. Plastic-to-Metal Transition Unions:
  - 1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.



## 2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  - 1. Description:
    - a. Standard: ASSE 1079.
    - b. Pressure Rating: 150 psig.
    - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric-Flange Insulating Kits:
  - 1. Description:
    - a. Nonconducting materials for field assembly of companion flanges.
    - b. Pressure Rating: 150 psig.
    - c. Gasket: Neoprene or phenolic.
    - d. Bolt Sleeves: Phenolic or polyethylene.
    - e. Washers: Phenolic with steel backing washers.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, NPS 2 and smaller shall be the following:
  - 1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered[ or pressure-seal] joints.
- B. Condensate-Drain Piping, Copper: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

### 3.2 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to the Section 232116 "Hydronic Piping Specialties."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install shutoff valve immediately upstream of each dielectric fitting.
- T. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors.
- W. Install sleeve seals for piping penetrations of concrete walls and slabs.
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors.

### 3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### 3.4 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 Use dielectric flanges.

### 3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- B. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting and coupling.
- D. Support vertical runs of copper tubing and steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections.

### 3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

### 3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
  - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
  - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
  - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
  - 3. Isolate expansion tanks and determine that hydronic system is full of water.
  - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
  - 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
  - 6. Prepare written report of testing.

- C. Perform the following before operating the system:
1. Open manual valves fully.
  2. Inspect pumps for proper rotation.
  3. Set makeup pressure-reducing valves for required system pressure.
  4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
  5. Set temperature controls so all coils are calling for full flow.
  6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
  7. Verify lubrication of motors and bearings.

END OF SECTION 232113

## SECTION 23 31 13.00 - METAL DUCTWORK

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Single-wall rectangular ducts and fittings.
  - 2. Single-wall round and flat-oval ducts and fittings.
  - 3. Sheet metal materials.
  - 4. Duct liner.
  - 5. Sealants and gaskets.
  - 6. Hangers and supports.
- B. Related Sections:
  - 1. Section 23 05 03 "Submittals for HVAC".
  - 2. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
  - 1. Liners and adhesives.
  - 2. Sealants and gaskets.
- B. Shop Drawings:
  - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  - 2. Factory- and shop-fabricated ducts and fittings.
  - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
  - 4. Elevation of top of ducts.
  - 5. Dimensions of main duct runs from building grid lines.
  - 6. Fittings.

7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Ductwork Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.

B. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

## PART 2 - PRODUCTS

### 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Dixie Sheetmetal
    - b. Eastern Sheetmetal of Cincinnati
    - c. Lindab
    - d. Semco Mfg., Inc.
    - e. Hranec
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support



intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
  2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- F. Fabricated ductwork shall comply with AMCA Standard 511 for air leakage.

### 2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G90.
  2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.4 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
    - a. CertainTeed Corporation; Insulation Group.
    - b. Johns Manville.
    - c. Knauf Insulation.
    - d. Owens Corning.
  2. Maximum Thermal Conductivity:
    - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

- 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - a. Fan discharges.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
8. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.

3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

## 2.6 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

- E. Trapeze and Riser Supports:
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

### PART 3 - EXECUTION

#### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3 INSTALLATION OF DUCT LINER

- A. General: Install duct liner in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
- B. Size of ductwork shown on the drawings is free net area, outside dimension of ducts will need to be increased if lined duct is used.
- C. Store internally lined ductwork up off of the floor. Protect internally lined ductwork from water and dust.
- D. Shop Application of Duct Liner:
  - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
  - 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
  - 3. Butt transverse joints without gaps, and coat joint with adhesive.
  - 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
  - 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
  - 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of **2500 fpm**.
  - 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at **3 inches** from transverse joints and at intervals not exceeding **18 inches** longitudinally.
  - 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
    - a. Fan discharges.
    - b. Intervals of lined duct preceding unlined duct.

- c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
- E. Inspect and repair all damaged lining prior to installation of ductwork.
- F. The following ductwork shall be lined:
  - 1. Return from open ceiling plenum return to HVAC unit.
  - 2. Transfer Air ducts.
  - 3. Supply and return between fan discharge and room terminal outlet(s) serving Theater space.
- G. The following ductwork shall be lined with flexible duct liner:
  - 1. Return ductwork in ducted return systems 10 feet downstream of HVAC unit.
  - 2. Exhaust ductwork 10 feet upstream and downstream of fans.
  - 3. Transfer air ducts.
  - 4. Supply and return between fan discharge and room terminal outlet(s) serving Theater space.
- H. The following ductwork shall be lined with rigid duct liner:
  - 1. Field or shop fabricated return air/outside air mixing plenums at HVAC units.

### 3.4 DUCT SEALING

- A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
  - 3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
  - 4. Unconditioned Space, Exhaust Ducts: Seal Class C.
  - 5. Unconditioned Space, Return-Air Ducts: Seal Class B.
  - 6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
  - 7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
  - 8. Conditioned Space, Exhaust Ducts: Seal Class B.
  - 9. Conditioned Space, Return-Air Ducts: Seal Class C.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.7 PAINTING

- A. All ductwork required to be painted shall be cleaned and oil-free. Mechanical Contractor shall prepare ductwork surfaces accordingly to accept primer and paint.
- B. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 09 91 23 "Interior Painting."

### 3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  2. Test the following systems:

- a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
  - b. Supply Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
  - c. Return Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
  - d. Exhaust Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
  - e. Outdoor Air Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  4. Test for leaks before applying external insulation.
  5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
  6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.
  2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.9 DUCT CLEANING

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
  1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
  2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:



1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
  2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
  2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  4. Coils and related components.
  5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
  6. Supply-air ducts, dampers, actuators, and turning vanes.
  7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
  2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
  3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
  4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
  5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
  6. Provide drainage and cleanup for wash-down procedures.
  7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

### 3.10 START UP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 23 31 13.00

## SECTION 23 33 00.00 - AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Manual volume dampers.
  - 2. Turning vanes.
  - 3. Duct-mounted access doors.
  - 4. Flexible connectors.
  - 5. Duct accessory hardware.
- B. Related Requirements:
  - 1. Section 23 05 03 "Submittals for HVAC".
  - 2. Section 28 31 15 "Duct Smoke Detectors".

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
  - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
    - a. Special fittings.
    - b. Manual volume damper installations.
    - c. Motor operated damper installations.
    - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
    - e. Duct security bars.
    - f. Wiring Diagrams: For power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

### PART 2 - PRODUCTS

#### 2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

#### 2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

#### 2.3 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Air Balance Inc.; a division of Mestek, Inc.
    - b. American Warming and Ventilating; a division of Mestek, Inc.

- c. Nailor Industries Inc.
- d. Pottorff.
- e. Ruskin Company.
- f. Vent Products Company, Inc.
- g. Greenheck Fan Corporation.
2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. For units less than 36" wide or 12" high
  - a. Frame shall be 22 gage galvanized steel.
  - b. Blade shall be single skin, 22 gage galvanized steel with center "V" groove for reinforcement.
  - c. Bearings shall be corrosion resistant synthetic sleeve type turning in an extruded hole in the damper frame.
  - d. Axles shall be 3/8" square shaft positively locked into damper blade.
5. For units over 36" wide and 12" high
  - a. Frame shall be 18 gage galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement.
  - b. Blades shall be single skin 18 gage galvanized steel with three longitudinal grooves for reinforcement.
  - c. Bearings shall be corrosion resistant synthetic sleeve type turning in an extruded hole in the damper frame.
  - d. Axles shall be hexagonal positively locked into damper blade.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

## 2.4 FLANGE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Eastern Sheetmetal.
3. Nexus PDQ; Division of Shilco Holdings Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

- D. Gage and Shape: Match connecting ductwork.

## 2.5 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Aero Dyne.
  - 2. Ductmate Industries, Inc.
  - 3. Duro Dyne Inc.
  - 4. Elgen Manufacturing.
  - 5. METALAIRE, Inc.
  - 6. SEMCO Incorporated.
  - 7. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
  - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

## 2.6 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Flexmaster U.S.A., Inc.
  - 3. Greenheck Fan Corporation.
  - 4. McGill AirFlow LLC.
  - 5. Ruskin.
  - 6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
  - 1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
    - d. Fabricate doors airtight and suitable for duct pressure class.
  - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  - 3. Number of Hinges and Locks:
    - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.

- b. Access Doors up to 18 Inches Square: Continuous hinge and two sash locks.
  - c. Access Doors up to 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.
  - d. Access Doors Larger Than 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
  2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts. Factory set at 3.0- to 8.0-inch wg.
  3. Doors close when pressures are within set-point range.
  4. Hinge: Continuous piano.
  5. Latches: Cam.
  6. Seal: Neoprene or foam rubber.
  7. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

## 2.7 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. Elgen Manufacturing.
  4. Ventfabrics, Inc.
  5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
  2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
  2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

## 2.8 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install motor operated dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel. These dampers, whether shown on the drawings or not, shall be installed at no additional cost to the Owner. Consult with Testing, Adjusting, and Balancing Agency prior to ductwork installation to establish damper locations
  1. Install steel dampers in steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  1. At outdoor-air intakes and mixed-air plenums.

2. Downstream from manual volume dampers, motor operated dampers, backdraft dampers, and equipment.
  3. Upstream and downstream from turning vanes.
  4. Control devices requiring inspection.
  5. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
  2. Two-Hand Access: 12 by 6 inches.
  3. Head and Hand Access: 18 by 10 inches.
  4. Head and Shoulders Access: 21 by 14 inches.
  5. Body Access: 25 by 14 inches.
  6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment. The use of flexible connectors as a means of duct transitions is prohibited.
- M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Connect flexible ducts to metal ducts with draw bands.
- O. Maximum length of flexible branch duct shall not exceed five feet and only be used at air devices.
- P. Install duct test holes where required for testing and balancing purposes.
- Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

### 3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
  2. Inspect locations of access doors and verify that purpose of access door can be performed.
  3. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00.00



## SECTION 23 74 33.00 – PACKAGED OUTDOOR ROOFTOP UNITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes package rooftop heating and cooling units of the following:
  - 1. Constant Volume Rooftop
- B. Related Sections:
  - 1. Section 23 05 03 “Submittals for HVAC”.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, furnished specialties and accessories; and installation and start-up instructions.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:
  - 1. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
  - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for rooftop heating and cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.
- E. Coordination Drawings: Rooftop replacement-air units to roof-curb mounting details drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  - 1. Size and location of rooftop replacement-air unit mounting rails and anchor points and methods for anchoring units to roof curb.

2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

F. Startup service reports.

G. Operation and Maintenance Data: Submit maintenance data and parts list for each rooftop units, including "trouble-shooting" maintenance guide, servicing guide and preventative maintenance schedule and procedures. Include this data in maintenance manual; in accordance with requirements of Division 1.

H. Warranty: Special warranty specified in this Section.

#### 1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop replacement-air units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Codes and Standards:

1. AHRI Compliance:
2. UL Compliance:
3. Energy Efficiency Ratio (EER) of rooftop units shall be equal to or greater than prescribed by ASHRAE 90A "Energy Conservation in New Building Design".
4. Rooftop units shall be listed by UL and have UL label as a unit.

#### 1.5 WARRANTY:

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Retain subparagraph below for units with fuel-fired furnaces.
3. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

B. Warranty on Compressor and Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors and heat exchangers with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

C. Warranty Period: 5 years from date of owner acceptance.

## PART 2 - PRODUCTS

### 2.1 CONSTANT VOLUME

- A. General: Rooftop unit shall be factory-assembled and tested, designed for roof or slab installation and, consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers. Capacities and electrical characteristics are scheduled.
- B. Acoustic Performance: Due to the acoustically sensitive nature of these spaces the units must meet the scheduled sound requirements as listed in the Packaged Rooftop Unit Schedule on sheet M-400 at a minimum. Units with higher discharge sound data than shown on the schedule will be rejected.
- C. Casing manufacturer's standard casing construction, having corrosion protection coating, and exterior finish. Casings shall have removable panels or access doors for inspection and access to internal parts, a minimum of 1" thick thermal insulation, knockouts for electrical and piping connections, and an exterior condensate drain connection, and lifting lugs.
  - 1. Unit casing shall have double wall construction with foam injected panels.
- D. Roof Curbs: Manufacturer's standard construction, insulated and having corrosive protective coating, complete with factory-installed wood nailer and drain nipple. Construction shall be in accordance with NRCA Standards.
- E. Evaporator Fans: Forward-curved, centrifugal, direct-driven fans with permanently lubricated motor bearings.
- F. Condenser fans: Propeller-type, direct-driven fans with permanently lubricated bearings.
- G. Coils: Aluminum plate fin and seamless copper tube type. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall have a galvanized steel casing. Coils shall be mounted in the coil casing with same end connections accessible for service. Coils shall be removable from the unit through the roof or through the piping enclosure. Coil section shall be completely insulated.
- H. Refrigerant cooling coils: have an equalizing type vertical distributor to ensure each coil circuit receives the same amount of refrigerant. Coils shall be proof (450 psig) and leak (300 psig) tested with air pressure under water, then cleaned, dehydrated, and sealed with a holding charge of nitrogen.
- I. Condensate Pan: Provide IAQ stainless steel, double sloping drain pan. Provide high condensate in primary condensate pan to de-energize unit upon detection of high condensate levels.
- J. Compressors: Serviceable, semi-hermetic, or hermetic compressors with integral vibration isolators, and crankcase heaters, which de-energize during compressor operation. Units shall also have:
  - 1. Lead compressor shall be 2-stage.

2. Compressors shall be variable capacity.
- K. Safety Controls:
1. low pressure cutout, manual reset;
  2. high pressure cutout, manual reset;
  3. compressor motor overload protection, manual reset;
  4. anti-recycling timing device;
  5. adjustable low-ambient lockout;
  6. oil pressure switch.
- L. Controls:
1. high limit cutout;
  2. Enthalpy Controlled Economizer Control:
    - a. Provide dual enthalpy economizer control. Provide return and outside air dampers, outside air filter, fully modulating electric control system with dry control, and adjustable mixed-air thermostat. System shall be capable of driving 100% closed for unoccupied mode, minimum outside air position and modulation to 100 percent open outside air capability. Provide automatic changeover through adjustable control device.
- M. Heating Types:
1. Hot water heat sections: manufacturer's standard construction hydronic heat coils.
- N. Temperature Control:
1. Temperature control: factory-installed, demand-oriented solid-state control system above 5 tons shall have minimum of 2 cooling steps and 2 heating steps. Controls shall include solid-state thermostats with dead-band, and sub-base with system and fan switches. Other control features include:
- O. Relief:
1. Power Exhaust Fan – Shall be factory installed for units larger than 5 tons. Shall include relief damper section with mist eliminator. Dampers open to relieve positive pressure within the building. Available only with economizer.
- P. Filters:
1. Provide air filters to fit in filter box, with a Maximum filter face velocity of 500 fpm, of the following type:
    - a. Disposable Type: Provide 30% efficient disposable type air filters 2" thick, consisting of viscous coated fibers with filtering media encased in fiberboard cell sides having perforated metal grids on each side to provide media support.
    - b. Cartridge Filters: Provide 85%, efficient 12" cartridge final filters.
  2. Provide filters with clean resistance not exceeding 0.10" w.g. at face velocity of 300 fpm, and ASHRAE weight arrestance efficiency of 70-82%, based on final operating resistance of 0.5" w.g.
- Q. Options:
1. Low Ambient Control - Shall allow compressor operation for cooling down to 0 F outside air temperature.
- R. Controls:

1. Self Contained: Programmable Electronic Night Setback Thermostat - Shall provide heating setback and cooling setup with 7-day, programming capability. Optional remote sensor available.
  
- S. Manufacturers: Subject to compliance with requirements, provide rooftop units of one of the following:
  - a. Daikin
  - b. Greenheck
  - c. Valent
  - d. Aaon

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and conditions under which rooftop units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### 3.2 INSTALLATION

- A. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. The rooftop unit(s) shall be installed a minimum of 10'-0" from any roof edge regardless of location indicated on plans, unless a screen wall or railing is installed per the local building code. See the architectural plans for coordination.
- C. Support: Install and secure roof curb to roof structure, in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.
- D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
- E. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirement of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.
- F. Start-up rooftop units, in accordance with manufacturer's start-up instructions. Test controls and demonstration compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- G. Condensate Piping: Provide Type L copper condensate piping with trap.

3.3 TRAINING OF OWNER'S PERSONNEL:

- A. Provide services of manufacturer's technical representative for 1-half day to instruct Owner's personnel in operation and maintenance of rooftop units.
- B. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

3.4 SPARE PARTS:

- A. General: Furnish to Owner, with receipt, the following spare parts for each rooftop unit:
  - 1. 1 set filters for each unit.

3.5 DEMONSTRATION:

- A. Start-Up Services:
  - 1. Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- B. Operating and Maintenance Training:
  - 1. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals specified in Division One.
  - 2. Schedule training with Owner, provide at least 7-day prior notice to the Architect/Engineer.

END OF SECTION 23 74 33.00

## SECTION 260010 -GENERAL REQUIREMENTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each Sub Contractor's work. Each Contractor is directed to familiarize themselves in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.
- C. Each Contractor shall be governed by any alternates, unit prices and Addenda or other contract documents insofar as they may affect their part of the work.

#### 1.2 SUMMARY

- A. Section Includes general requirements applicable to work specified in Divisions 26.
- B. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of complete and operating Electrical Systems indicated on the drawings and/or specified herein.
- C. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Electrical Systems in a substantial manner, in compliance with the requirements stated, implied, or intended in the drawings and specifications, shall be included as part of this Contract. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in their bid, and that they will be responsible for the approved satisfactory functioning of the entire system without extra compensations.
- D. It is not the intent of this section of the specifications (or the remainder of the contract documents) to make any specific Contractor, other than the Contractor holding the prime contract, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be done through the Contractor to the Architect (if applicable), then to the Engineer.
- E. This section of the Specifications or the arrangement of the contract documents shall not be construed as an attempt to arbitrarily assign responsibility for work, material, equipment or services to a particular trade Contractor or Sub-Contractor. Unless stated otherwise, the

subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

F. Any reference within these specifications to a specific entity, i.e., "Electrical Contractor" is not to be construed as an provide to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor holding the prime contract, unless otherwise provided herein.

G. In each of the specifications and drawings referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

H. Intent and Interpretation

1. It is the intent of these specifications and all associated drawings that the Contractor provide finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete, tested and ready for operation."
2. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.
3. It is the intention of the Contract Documents to call for a complete and operational system, including all components, accessories, finish work, etc. as necessary for trouble free operation; tested and ready for operation. Anything that may be required, implied, or inferred by the Contract Documents shall be provided and included as part of the Bid.
4. All Contractors and Vendors providing a bid for this project shall review the Plans and Specifications and determine any modifications and/or adjustments necessary relative to the proposed equipment and materials with specific manufacturer's installation requirements. Include in the bid any necessary installation methods, features, options, accessories, etc. necessary to install the proposed equipment and materials, regardless of whether used as basis of design or being offered as a substitution in accordance with the specific manufacturer's installation requirements whether specifically detailed or not within the Plans and Specifications.
5. The Bidder/Proposer shall completely review the Contract Documents. Any interpretation as to design intent or scope shall be provided by the Engineer/ Architect. Should an interpretation be required, the Bidder/Proposer shall request a clarification not less than ten days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event of any conflict, discrepancy, or inconsistency develops; the interpretation of the Engineer shall be final.
6. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in the bid, and that will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

I. Drawings and Specifications

1. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted in writing to the Engineer for approval before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be



- necessary to complete the systems. Contractors shall, however, anticipate that additional offsets may be required and submit their bid accordingly.
2. The drawings and specifications are intended to supplement each other. No Contractor, bidder, proposer or supplier shall take advantage of conflict between them, or between parts of either, but should this condition exist, the Contractor or supplier shall request a clarification of the condition at least ten days prior to the submission of bids so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.
  3. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.
  4. This Contractor shall make all their own measurements in the field and shall be responsible for correct fitting. They shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.
  5. The Engineer shall reserve the right to make minor adjustments in location of conduit, fixtures, outlets, switches, etc., where they consider such adjustments desirable in the interest of concealing work or presenting a better appearance.
  6. Each Contractor shall evaluate ceiling heights called for on Architectural Plans and ensure that these heights may be maintained after all mechanical and electrical equipment is installed. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.
  7. Should overlap of work between the various trades become evident, this shall be called to the attention of the Engineer. In such an event, neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.
  8. The Electrical drawings are intended to show the approximate location of equipment, materials, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions whether given in figures or scaled shall be verified in the field. In case of conflict between small- and large-scale drawings, the larger scale drawings shall take precedence.
  9. The Electrical Contractor and their Sub-Contractors shall review all drawings in detail as they may relate to his work (structural, architectural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetration points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineers at least ten days prior to bids, for issuance of clarification by written addendum.
  10. Where on any of the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornament or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

### 1.3 COST BREAKDOWN AND PAY APPLICATIONS

- A. Within thirty days after acceptance of the Contract, each Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer or Architect. Payments will not be made until satisfactory cost breakdowns are submitted. Refer to Division 00 and 01 specification sections for additional requirements.
- B. In addition to cost breakdowns by specification section, the following shall also be provided: Material and labor shall be listed separately. These items are in addition to items listed in Division 01 specifications. Pay special attention to required withholding percentages for startup, testing, documentation, acceptance, owner training, etc. The breakdown shall be minimally as follows:
  - 1. Permitting
  - 2. Mobilization
  - 3. Electrical Submittals
  - 4. Branch Circuiting Materials & Labor
  - 5. Electrical Devices Materials & Labor
  - 6. Punchlist
  - 7. As-Built/Record Drawings
  - 8. O&M Manuals
  - 9. Warranty
  - 10. Demobilization

### 1.4 REFERENCES

- A. Abbreviations and Acronyms
  - 1. A, AMP: Ampere
  - 2. ADA: Americans with Disabilities Act.
  - 3. AFF: Above Finished Floor
  - 4. AFG: Above Finished Grade
  - 5. AHJ: Authority Having Jurisdiction
  - 6. AHU: Air Handling Unit
  - 7. AIC: Amps Interrupting Capacity
  - 8. ANSI: American National Standards Institute.
  - 9. ASA: American Standards Association.
  - 10. ASTM: American Society for Testing Materials.
  - 11. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.
  - 12. ATS: Automatic Transfer Switch
  - 13. A/V: Audio/Visual
  - 14. AWG: American Wire Gauge
  - 15. BAS: Building Automation System
  - 16. BFG: Below Finished Grade
  - 17. BICSI: Building Industry Consulting Services International
  - 18. C: Conduit
  - 19. CB: Circuit Breaker
  - 20. CFCI: Contractor Furnished, Contractor Installed
  - 21. CFOI: Contractor Furnished, Owner Installed
  - 22. CKT: Circuit

23. CLG: Ceiling
24. CT: Current Transformer
25. CM: Construction Manager
26. DDC: Direct Digital Building Controls
27. DOAS: Dedicated Outdoor Air System
28. DWG: Drawing
29. EC: Electrical Contractor
30. ELEV: Elevator
31. EM: Emergency
32. EPO: Emergency Power Off
33. FA: Fire Alarm
34. FAA: Fire Alarm Annunciator
35. FACP: Fire Alarm Control Panel
36. FCC: United States Federal Communications Commission
37. FFE: Finished Floor Elevation
38. FLA: Full Load Amps
39. G, GND: Ground
40. GFCI: Ground Fault Circuit Interrupter
41. GC: General Contractor
42. HOA: Hands Off Auto
43. HP: Horsepower
44. IDF: Intermediate Distribution Frame
45. IECC: International Energy Conservation Code
46. ISO: International Standards Organization.
47. IT: Information Technology
48. KVA: Kilovolt-Amperes
49. KW: Kilowatt
50. KWH: Kilowatts Hours
51. LRA: Locked Rotor Amps
52. LTG: Lighting
53. MC: Mechanical Contractor
54. MCA: Minimum Circuit Ampacity
55. MCB: Main Circuit Breaker
56. MDF: Main Distribution Frame
57. MDP: Main Distribution Panel
58. MLO: Main Lugs Only
59. MOCP: Maximum Overcurrent Protection
60. MSB: Main Switchboard
61. N/A: Not Applicable
62. NEC: National Electrical Code
63. NECA: Standards for Installation.
64. NEMA: National Electrical Manufacturers Association.
65. NESC: National Electrical Safety Code.
66. NFPA: National Fire Protection Association.
67. NIC: Not in Contract
68. NRTL: Nationally Recognized Testing Laboratory
69. NTS: Not to Scale
70. N/A: Not Applicable
71. OFCI: Owner Furnished, Contractor Installed
72. OFOI: Owner Furnished, Owner Installed

73. OSHA: Office of Safety and Health Administration.
74. P: Pole, Poles
75. PC: Plumbing Contractor
76. PIR: Passive Infrared
77. RFI: Request for Information
78. RIO: Rough-in Only
79. RM: Room
80. SPD: Surge Protection Device
81. SS: Stainless Steel
82. SWBD: Switchboard
83. TIA: Telecommunications Industry Association
84. TYP: Typical
85. UL: Underwriters Laboratories, Inc.
86. UON or UNO: Unless otherwise noted.
87. UG: Underground
88. V: Volt, Volts
89. VFD: Variable Frequency Drive
90. W: Watts
91. WG: Wire Guard
92. WP: Weather Proof
93. XFMR: Transformer

B. Definitions

1. Architect: The Architect of Record for the project, if applicable.
2. Basis of Design (BOD): Documentation of primary thought processes and assumptions behind design decisions made to meet design intent. Describes systems, components, conditions and methods chosen to meet intent.
3. Bidder/Proposer: Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.
4. Contract Documents: All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Manager's Assignments, Architect's Supplemental Instructions, Construction Contract with Owner, etc.
5. Contractor: Any Contractor whether bidding, proposing or working independently or under the supervision of a General Contractor, Prime Contractor, or Construction Manager and who installs any type of Electrical Work as specified in the Contract Documents.
6. Electrical Contractor: Any Contractor whether bidding or working independently or under the supervision of the entity holding the Prime Contract and who installs any type of Electrical work, such as: power, lighting, television, telecommunications, data, fiber optic, intercom, fire detection and alarm, security, video, underground or overhead electrical, etc.
7. Electrical Sub-Contractor: Each or any Contractor contracted to, or employed by, the Electrical Contractor for any work required by the Electrical Contractor.
8. Engineer: The Consulting Mechanical-Electrical Engineer consulting to the Owner, Architect, or Other, etc.
9. Indicated: Listed in the Specifications, shown on the Plans or Addenda thereto.
10. Install: Install equipment furnished by others in complete working order.

11. Installer: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
12. Furnish: Deliver to the site in good condition and turn over to the Contractor who is to install.
13. Prime Contractor: The Contractor who has been engaged by the Owner in a contractual relationship to accomplish the work.
14. Project: All of the work required under this Contract.
15. Provide: Furnish and install complete, tested and ready for operation.
16. Start-Up: The activities where systems or equipment are initially tested and operated. Start-up is completed prior to functional testing.
17. Typical: Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.
18. Vendor: Supplier of equipment.

C. Reference Standards: Contractor is responsible for knowledge and application of current versions of all applicable standards and codes. Contractor shall adhere to the most recent revisions or version adopted by the Authorities Having Jurisdiction, including all relevant changes or addenda at the time of installation.

1. IEEE – Institute of Electrical and Electronics Engineers.
  - a. IEEE C2, National Electrical Safety Code
2. NECA – National Electrical Contractors Association.
  - a. NECA 1, Standard for Good Workmanship in Electrical Construction
3. NFPA - National Fire Protection Association.
  - a. NFPA 70, National Electrical Code (NEC)
4. OSHA - The Occupational Safety and Health Act

## 1.5 COORDINATION

A. Interruption of Existing Services: In general, and to the extent possible, perform all work without interruption of the existing facilities' operations. Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify the Owner, Architect, and Engineer no fewer than seven days in advance of proposed interruption of service.
2. Provide the exact time the interruption will occur and the length of the interruption.
3. Do not proceed with interruption of service without written permission from Owner, Architect, and Engineer.
4. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.
5. Contractor will not be entitled to additional compensation due to work stoppage mandated by unscheduled interruption.
6. Coordinate interruptions with systems impacted by outages including but not limited to the following:
  - a. Fire Alarm Systems

7. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore the service. The Contractor shall provide tools, materials, skilled journeymen of their own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work.

B. Coordination Between Trades

1. The Contractor is expressly directed to read the General Conditions and all detailed sections of these specifications for all other trades and to study all drawings applicable to their work, including Architectural, Mechanical, Structural and other pertinent Drawings, to the end that complete coordination between trades will be affected.
2. The Contractor is responsible for the correct location of all rough-in and connections at every piece of equipment. Work not correctly located shall be relocated at the Contractor's expense.
3. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.
4. Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than  $\frac{1}{4}$  inch = 1 Foot, clearly indicating how his work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. The Contractor shall make the necessary changes in his work to correct the condition without extra charge.
5. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

C. Temporary Services

1. The Contractor shall arrange for temporary electrical and other services required to accomplish the work. In the absence of other provisions in the contract, the Contractor shall provide for temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in their bid.
2. All temporary services shall be removed by Contractor prior to acceptance of work.

D. Temporary Use of Equipment

1. The permanent electrical equipment, when installed, may be used for temporary services, subject to an agreement among the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without additional cost to the Owner, leaving the equipment and installation in "as new" condition. The Contractor may be required to bear utility costs, user fees, etc.
2. Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result from its use.

## 1.6 SUBMITTALS

- A. Review of submittals by the Engineer applies only to conformance with the design intent of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.
- B. The Engineer's review of submittals, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.
- C. If a submittal deviates from the drawings or specifications because of Contractor's standard practice, approved substitution request, or any other reason, the submittal shall notify the designer of the deviation.
- D. Prior to the start of work the contractor shall submit the following. Work shall not proceed without the Engineer's and Owner's completed review of the submitted items.
- E. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
  - 1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Clearly and precisely mark red notations and yellow highlights on the submittal to show which products and options are applicable.
  - 3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts.
    - d. Statement of compliance with specified referenced standards.
    - e. Testing by recognized testing agency.
    - f. Application of testing agency labels and seals.
    - g. Notation of coordination requirements.
    - h. Rated capacities, operating characteristics, and electrical characteristics,
    - i. Wiring diagrams that show factory-installed wiring and interface points.
    - j. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  - 4. Format and Organization: submit bookmarked electronic PDF files complying with the following:
    - a. Cover: Clearly display the following information: Owner name, Project name, Submittal name, project submittal number, Contractor name and contact information, and applicable specification section numbers.
    - b. Table of Contents: Include a TOC that lists materials by section number, with a brief product description, manufacturer and part number, and list the submittal page number per product
    - c. Product Information

- F. Product Schedules: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
  2. Manufacturer and product name, and model number if applicable.
  3. Number and name of room or space.
  4. Location within room or space.
- G. Shop Drawings: Prepare Project-specific information, drawn accurately to scale.
1. Shop Drawings that are reproductions of the Contract Documents are not permitted and will be rejected.
  2. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    - b. Mounting Details
    - c. Wiring diagrams and installation details
    - d. Identification of products.
    - e. Schedules.
    - f. Compliance with specified standards.
    - g. Notation of coordination requirements.
    - h. Notation of dimensions established by field measurement.
    - i. Seal and signature of professional engineer if specified.
- H. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

## 1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of five years unless otherwise approved.
1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.
  2. Equipment shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
- B. Installer Qualifications
1. All Electrical Contractors bidding this project must have been a licensed company for a minimum of three years to qualify to bid this project. Individual employee experience does not supersede this requirement.



2. All subcontractors bidding the electrical work must have completed one project of 70 percent this subcontract cost size and two projects of 50 percent this subcontract cost size.
3. All electrical work shall be accomplished by qualified workers competent in the area of work for which they are responsible. Untrained and incompetent workers as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any worker and unqualified or incompetent workers shall refrain from work in areas not satisfactory to them. Requests for relief of a worker shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.
4. All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician.

- C. Licensed Professional Engineer Qualifications: Professional Engineer possessing active qualifications in accordance with Division 01 and licensed by the State in which the Work is being performed.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver or install indoor equipment until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

#### 1.9 FIELD CONDITIONS

- A. Ambient Conditions:
1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 104 deg F.
    - b. Altitude: Not exceeding 6600 feet.

#### 1.10 WARRANTIES

- A. Contractor Warranty: Contractor shall unconditionally guarantee all equipment, apparatus, materials, and workmanship entering into this Contract to be the best of its respective kind and shall replace all parts at their own expense, which fail or are proven defective within one year from Substantial Completion of the work by the Engineer. The effective date of completion of the work shall be the date each or any portion of the work is accepted by the Architect, Engineer, and Owner's Statement of Substantial Completion.
- B. Manufacturer Warranty: Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate

the guarantee except that the Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

- C. The Warranties specified herein and other Sections shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

#### 1.11 INDEMNIFICATION

- A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

#### 1.12 HAZARDOUS MATERIALS

- A. The Contractor is hereby advised that it is possible that asbestos and/or other hazardous materials are or were present in this building(s). Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of their work, ensure their workers are aware of this potential and what they are to do in the event of suspicion. The Contractor shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.
- B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.
- C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner immediately.
- D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency suitable to the AHJ, and marked for intended location and application.
- B. Materials used shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards, other applicable federal, state, and local laws.
- C. Standard Products
  - 1. Except where specifically noted otherwise, all equipment supplied by the Contractor shall be the standard products of a single manufacturer of known reputation and experience in the industry.
  - 2. Only equipment, components and accessories in current production for at least five years beyond the completion date of this system shall be used and installed. Any equipment found to be obsolete or not in future production will be removed and replaced at Contractor's expense. This includes all equipment, materials and labor.
  - 3. Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.
- D. Product numbers are subject to change by the manufacturer without notification. In the event a product number is invalid or conflicts with the written description, notify the Engineer in writing prior to ordering the material and performing installation work.

### 2.2 PRODUCT SUBSTITUTIONS

- A. Conform to the substitutions requirements and procedures outlined in Division 01.
- B. One substitution for each product specified will be considered and substitutions must be submitted to Engineer a minimum of 10 days prior to bid using the standard CSI substitution request form.
- C. If prevailing laws of cities, towns, states or countries are more stringent than these specifications regarding such substitutions, then those laws shall prevail over these requirements.
- D. Where products are noted as "or equal", a product of equivalent design, manufacture, and performance will be considered. Submit product data (product information, catalog cut sheets, test data, etc.) to substantiate that the product is in fact equivalent to that specified. The burden of proof that the substituted product is equivalent to the specified product rests with the Contractor. Whenever material, process or equipment is specified in accordance with an industry specification (ANSI, TIA, etc), UL rating, or other association standard, present an affidavit from the manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, submit supporting test data to substantiate compliance.
- E. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the contract documents are used to establish standards of quality, utility and appearance and shall not be construed as limiting competition. Materials, processes or

equipment that, in the opinion of the Engineer, are equivalent in quality, utility and appearance will be approved as substitutions to that specified when "or equal" follows the manufacturers' names or model number(s).

- F. When the Engineer accepts a substitution in writing, it is with the understanding that the Contractor guarantees the substituted product, component, article, or material to be equivalent to the one specified and dimensioned to fit within the construction according to contract documents. Do not provide substituted material, processes, or equipment without written authorization from the Engineer. Assumptions on the acceptability of a proposed substitution, prior to acceptance by the Engineer, are at the sole risk of the Contractor.
- G. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the work, or from provisions of the specifications.
- H. Contractor shall pay expenses, without additional charge to the Owner, in connection with substitution materials, processes and equipment, including the effect of substitution on their work or other Contractor's work.
- I. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall advise all such Contractors of the change and shall reimburse them for all necessary changes in their work. Any Drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Review of Shop Drawings by the Engineer does not absolve the Contractor of this responsibility.
- J. Contractor shall be responsible and assume all costs for removal and replacement of any substituted product installed without prior written approval. Such costs shall include, but not be limited to labor, materials as well as any penalties, fees or costs incurred for late completion.

### PART 3 - EXECUTION

#### 3.1 INSTALLERS

- A. Supervision of Work: Each Contractor and Sub-Contractors shall personally supervise the work or have a competent superintendent on the project site at all times during progress of the work, with full authority to act in matters related to the project.
- B. Conduct of Workmen: The Contractor shall be responsible for the conduct of all workmen under their supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden. Possession of a fire-arm is prohibited and may result in prosecution. Foul or bad language, graffiti is strictly prohibited.
- C. No tobacco use, including smokeless tobacco, is allowed on property.

### 3.2 EXAMINATION

- A. Each Contractor shall inform themselves of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. All Contractors shall carefully examine all Drawings and Specifications and inform themselves of the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of their work.
- B. Each Contractor shall fully acquaint themselves with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in their work all expenses or disbursements in connection with such matters and conditions. Each Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

### 3.3 PREPARATION

- A. Surveys, Measurements, and Grades
  - 1. The Contractor shall lay out their work and be responsible for all necessary lines, levels, elevations and measurements. They must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from their failure to do so.
  - 2. Base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.
  - 3. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, they shall notify the Engineer through normal channels of job communication and shall not proceed with his work until they have received instructions from the Engineer.

### 3.4 INSTALLATION

- A. At no time shall the contractor work on energized electrical equipment. Contractor shall comply with NFPA 70E requirements at all times throughout construction.
- B. Permits and Fees
  - 1. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, and other costs in connection with their work. As necessary, the Contractor shall file all required plans, utility easement requests and drawings, survey information on line locations, load calculations, etc., prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all required certificates of inspection for their work and deliver same to the Engineer before request for final acceptance and final payment for the work.

2. Ignorance of Codes, Rules, regulations, utility company requirements, laws, etc., shall not diminish or absolve Contractor's responsibilities to provide and complete all work in compliance with such.

C. Codes and Regulations

1. The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus or drawings required in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on drawings and/or specified.
2. All materials furnished and all work installed shall comply with the adopted edition of the National Electrical Codes, National Fire Codes of the National Fire Protection Association, the requirements of local utility companies, and with the requirements of all governmental agencies or departments having jurisdiction.
3. All electrical work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the AHJ, as applicable or required. Electrical work shall not commence until such plans are in the hands of the Electrical Contractor.
4. The Contractor shall insure their work is accomplished in accord with OSHA Standards and any other applicable government requirements.
5. Where conflict arises between any code and the contract documents, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at their own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

D. Materials and Workmanship

1. All electrical equipment, materials and articles incorporated in the work shall be new and of equal quality to the specified basis of design. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades.
2. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).
3. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein.
4. All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.
5. Comply with National Electrical Contractors Association (NECA) performance standards that are published as National Electrical Installation Standards (NEIS).
6. All applicable equipment and devices provided shall meet all FCC requirements and restrictions.

E. Weatherproofing

1. Where any work penetrates waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.
2. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

F. Equipment Access

1. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of their work. Cooperate with the Prime Contractor and all other Contractors whose work is in the same space, and advise each Contractor of equipment requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.
2. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.
3. Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work. In the absence of such specifications, at a minimum such work shall comply with the specifications below. All locations for access panels which are not specifically indicated on the drawings shall be submitted to and approved by the architect prior to ordering.
4. Access Doors; in Ceilings or Walls:
  - a. In mechanical, electrical and service spaces: 14-gauge aluminum brushed satin finish, 1" border.
  - b. In finished areas: 14-gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.
  - c. In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.

G. Connections

1. Provide rough-in and final connections to all electrically operated equipment furnished under the Work of the contract documents. Carefully coordinate with equipment suppliers, manufacturer's representatives, vendors, and other trades to provide complete electrical and dimensional interface to all equipment.
2. Provide all power wiring complete from power source to motor or equipment junction box, including power wiring through starters or contactors. Install all starters not factory mounted on equipment.
3. Provide all control, interlock, sensor, thermocouple and other connections required for equipment operation. Coordinate ampacity and voltage characteristics for all motors and equipment.

4. Prior to bidding the work, coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other trades, to ensure all needed wiring is provided. Failure to provide such coordination shall not be justification for claims of extra compensation of a time extension to the Contract.
  5. At no times shall the contractor work on energized electrical equipment. Comply with NFPA 70E requirements at all times during construction.
- H. Scaffolding, Rigging, and Hoisting: The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

### 3.5 RESTORATION

- A. The Contractor shall replace to their original condition all paving, curbing surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item to be replaced. All repairs shall be to the satisfaction of the Engineer, and in accord with the Architect's standards for such work, as applicable. Patchwork on new construction will not be accepted.

### 3.6 IDENTIFICATION AND OPERATING INSTRUCTIONS

- A. Provide all equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.
- B. Provide operating instructions for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:
1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
  2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
  3. Safety precautions.
  4. The procedure in the event of equipment failure.
  5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.
- C. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.



### 3.7 SYSTEM TESTING, VERIFICATION, AND START-UP

- A. The Contractor (and Sub-Contractors) shall be responsible for starting-up, testing, checking, examining, inspecting, and verifying their systems.
- B. The Electrical Contractor shall designate an individual under their employment to lead the start-up, testing and verification process. This person should not be the project manager or job site superintendent, but a person dedicated to making this critical task successful and completed in a timely manner.
- C. The Contractor shall include in the bid to provide systems startup and verification for all electrical systems specified for this project. Specific startup, testing, and verification requirements are included throughout the Electrical specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians (unless noted otherwise) and shall complete and submit start-up reports/checklists. Submit start-up reports to the Engineer. The Contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner.
- D. Where manufacturer start-up is not specified for a particular piece of equipment or system, the Contractor shall be responsible to perform start-up in strict accordance with manufacturer's instructions.
- E. The Contractor shall be responsible for completion of a System Verification Checklist (SVC) / Manufacturer's Checklists. Furnish to the Testing Agent and Engineer. Sample checklists shall be submitted to the Engineer, Owner, and Testing Agent for approval.
- F. The completed reports shall be organized and bound together in a tabbed binder and submitted for review and approval.

### 3.8 FIELD QUALITY CONTROL

- A. Inspections
  - 1. Before requesting a final review of the installation from the Architect and/or Engineer, the Contractor shall thoroughly inspect the installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.
  - 2. Owner's and Engineer's inspections: Two inspections will be held to generate and then review punchlist items. All site inspections and visits thereafter shall be billed to the Contractor at the Engineer's standard hourly rates.
  - 3. The Contractor shall provide as a part of this contract electrical inspection by a competent Electrical Inspection Agency, licensed to provide such services. The name of this agency shall be included in the list of materials of the Form of Proposal by the Contractor. All costs incidental to the provision of electrical inspections shall be borne by the Electrical Contractor.
  - 4. The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when they anticipate commencing work. Failure of the Inspection Agency to inspect the work in the stage following and

submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Costs associated with any rework, cutting, and patching will be at the expense of the responsible Contractor.

5. Inspections shall be scheduled for rough-in as well as finished work. The rough inspections shall be divided into as many inspections as may be necessary to correct deficiencies. Report of each such inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.
6. Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.
7. Before final acceptance, the Contractor shall furnish three copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

#### B. Punch Lists

1. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least three stages of the project.
  - a. For review of in-wall work that will be concealed by drywall or other materials well before substantial completion.
  - b. For review of the above-ceiling work that will be concealed by tile or other materials well before substantial completion.
  - c. For review of all other work as the project nears substantial completion.
2. When all work from the Contractor's punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing two weeks prior to the proposed date.
3. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the ceilings being installed and at the final punch list review.
4. At the engineer's option, the contractor shall supply digital photographs via email or file-share of any installed work.
5. If additional visits are required by the Engineer to review work not completed by this review, the Engineer shall be reimbursed directly by the Contractor by check or money order (due 10 days from date of each additional visit) at a rate of \$125.00 per hour for extra trips required to complete either of the above-ceiling or final punch lists.
6. All panelboard fronts shall be removed prior to final punch list inspection and re-installed after completion. Directories for each panelboard shall be completed and available for review by the Engineer at that time.

### 3.9 CLEANING

- A. The Contractor shall, at all times, keep the area of work presentable to the public and clean of rubbish caused by their operations; and at the completion of the work, shall remove all rubbish, all tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the Contractor does not attend to such cleaning

immediately upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the responsible Contractor. Each Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of rubbish or debris.

- B. After completion of all work and before final acceptance of the work, each Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of materials, equipment and all associated fabrication. Pay particular attention to finished area surfaces such as lighting fixture lenses, lamps, reflectors, panels, etc.

### 3.10 PROTECTION

- A. The Contractor shall be entirely responsible for all material and equipment furnished for their work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. Equipment damaged while stored on site either before or after installation shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor. Electrical equipment exposed to the weather shall be replaced by the Contractor at their own expense.

END OF SECTION

## SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Slotted Support Systems.
  - 2. Conduit and Cable Supports.
  - 3. Mounting, Anchoring, and Attachment Components.
  - 4. Fabricated Metal Supports.
  - 5. Concrete Bases.
  - 6. Vibration Isolation pads.
  - 7. Sleeves for penetration of non-fire-rated construction walls and floors.
  - 8. Sleeve-seal systems.
  - 9. Firestopping.
  - 10. Cutting and Patching
  - 11. Painting

#### 1.3 REFERENCES

- A. Abbreviations and Acronyms
  - 1. EMT: Electrical Metallic Tubing.
  - 2. FMC: Flexible Metal Conduit.
  - 3. GRC/GRS: Galvanized Rigid Steel Conduit.
  - 4. LFMC: Liquid-tight flexible metal conduit.
  - 5. RMC: Rigid Metal Conduit
- B. Definitions
  - 1. Channel: A continuous slotted channel (strut) with inturned lips suitable for assembly into multiple configurations
- C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
  - 1. Metal Framing Manufacturers Association (MFMA)
    - a. MFMA-4: Metal Framing Standards Publication

b. MFMA-103: Guidelines for the use of Metal Framing

1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations with Division 07 Section "Roof Accessories."

1.5 SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of components, profiles, and finishes.
  - 2. Include rated capacities.
- B. Shop Drawings: For fabrication and installation details and include calculations for the following:
  - 1. Slotted channel systems.
  - 2. Equipment supports.
  - 3. Concrete Bases for Equipment.
  - 4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: Signed and sealed by a qualified professional engineer. For field assembled or fabricated hangers and supports for electrical systems.
  - 1. Include design calculations and details of trapeze hangers.
- D. Qualification Data: For professional engineer.

1.6 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to the authority having jurisdiction, and marked for intended location and application.

- B. Delegated Design: Design support systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

## 2.2 SLOTTED SUPPORT SYSTEMS

- A. Description: Preformed, continuous slot, bolted channels with associated fittings and hardware.
  - 1. Available Manufacturers: Subject to compliance with requirements, provide products from one of the following or an approved equal:
    - a. Eaton B-Line.
    - b. Kindorf.
    - c. nVent Caddy.
    - d. Power-Strut.
    - e. SuperStrut.
    - f. Unistrut.
  - 2. Comply with MFMA-4 for factory fabricated components suitable for field assembly.
  - 3. Material and Finish for channel, fittings, and accessories:
    - a. Steel: Minimum 16 gauge, Hot-dip galvanized after fabrication and applied according to ASTM A123 or A153 suitable for indoor or outdoor wet locations.
  - 4. Channel Dimensions: Minimum 1-5/8 inches wide with varying heights and welded combinations selected to meet applicable load criteria.

## 2.3 CONDUIT AND CABLE SUPPORTS

- A. Available Manufacturers: Subject to compliance with requirements, provide products from one of the following or an approved equal:
  - 1. Eaton B-Line
  - 2. nVent Caddy
  - 3. Thomas & Betts
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Provide plugs with number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported.
- D. Device Box Mounting Brackets: Factory-fabricated sheet steel brackets for support of device boxes adjacent to or between studs.
- E. Through-Stud Cable and Raceway Support Clips: Factory-fabricated spring steel clip for cables or raceways where run horizontally through metal studs.

- F. Roof-mounted Raceway Support Blocking: Non-penetrating, factory-fabricated support blocking for use under roof-mounted raceways. Wedge-shaped blocking constructed of 100% recycled UV-resistant Rubber with integral galvanized steel strut to accept raceway support clips.
- G. Tee Bar Grid Box Hanger: Factory-fabricated metal electrical box hanger for supporting boxes at locations between ceiling system t-grid components. Height adjustable for various electrical box depths. Attached to ceiling tee bar with screws or integral clamp for stability. Includes tab for independent support wire attachment.

## 2.4 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Eaton B-Line
  - 2. Empire Industries.
  - 3. Hilti.
  - 4. ITW.
  - 5. MKT Fastening.
- B. Description: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
  - 2. Concrete Inserts: Steel, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  - 5. Toggle Bolts: All-steel springhead type.
  - 6. Hanger Rods: Solid, threaded steel.

## 2.5 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

## 2.6 VIBRATION ISOLATION PADS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Korfund Maxi-Flex Pads or a comparable product by one of the following:
  - 1. Ace Mountings Co.
  - 2. California Dynamics Corporation.

3. Eaton B-Line.
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibration Eliminator Co.
7. VMC Group

- B. Description: Molded, oil resistant, non-skid elastomeric pads arranged in 2-inch square segments.
- C. Size: Factory or field cut to match requirements of supported equipment.
- D. Load Rating from 120 lbs. up to 360 lbs. per 2-inch segment.

## 2.7 SLEEVES

- A. Wall and Floor Sleeves:
1. Galvanized Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

## 2.8 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable. Link Seal system or approved equal.
1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  2. Pressure Plates: Glass reinforced nylon polymer.
  3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.9 FIRESTOPPING FOR ELECTRICAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products from one of the following or approved equal:
1. Hilti
  2. Specified Technologies Inc (STI)
  3. Wiremold
- B. Source Limitations: Obtain firestopping systems through one source from a single manufacturer.
- C. General Requirements:
1. Firestopping systems shall bear UL classification marking corresponding to its Fire Resistance Directory.
  2. Comply with testing requirements set forth in ASTM E814 or UL 1479.
  3. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration



- firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
4. Provide components for each through-penetration firestop system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- D. Fire rated cable pathways: Re-penetrable, maintenance-free cable management devices for use with cable bundles penetrating through fire rated walls or floors.
1. Shall contain a built-in fire sealing system sufficient to maintain the hourly rating of the fire rated wall or floor being penetrated.
  2. The system shall adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or reinstall firestop materials.
  3. Shall be engineered to allow two or more devices to be ganged together with wall plates for larger cable capacities.
- E. Fire-rated cable grommets: Molded, two-piece grommet with sealing membrane for use with single cables or small bundles at through or membrane wall penetrations.
1. System shall be installed around cables and shall lock tightly into the wall assembly.
- F. Outlet Box Putty Pads: Non-hardening, moldable, intumescent material shaped into preformed pads for use with metallic outlet boxes.
- G. Refer to Division 07 for requirements related to other firestopping systems and materials.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation devices for compliance with manufacturer's installation requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 CUTTING AND PATCHING

- A. Unless otherwise indicated, provide cutting and patching necessary to install the work specified. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accordance with the Architect's standards for such work.

- B. Do not cut structural elements without reinforcing the structure to maintain the designed weight bearing and stiffness. Coordinate approved reinforcement method with Architect and Structural Engineer.

### 3.3 SUPPORT SYSTEM APPLICATION

- A. Comply with NFPA 70, NECA 1, NECA 101, and MFMA-103 for application of hangers and supports for electrical equipment and systems except where requirements of this Section are more stringent.
- B. Maximum Horizontal and Vertical Support Spacing for Raceway(s): Space supports for raceways as required by NFPA 70.
- C. Minimum Hanger Rod Size for Raceway Supports: 3/8-inch diameter unless noted otherwise.
- D. Single Raceways:
  - 1. For Raceways 1-1/4-inch and smaller: Install adjustable steel band hanger suspended on threaded rod.
  - 2. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/4-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. Multiple Raceways and single raceways larger than 1-1/4-inch:
  - 1. Install trapeze-type supports fabricated with slotted support system suspended on threaded rods for horizontal applications and fastened to building structure for vertical applications.
  - 2. Size so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 3. Secure raceways and cables to these supports with two-bolt steel conduit clamps or single-bolt steel conduit clamps using spring friction action for retention in support channel.

### 3.4 SUPPORT SYSTEM INSTALLATION

- A. Comply with NFPA 70, NECA 1, NECA 101, and MFMA-103 for installation requirements except where requirements of this Article are more stringent.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components multiplied by a safety factor of four with a minimum of 200 lbs.
- C. Mounting and Anchorage of Surface-Mounted or Recessed-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
    - a. Where support anchors are required, establish their type and locate in concrete construction before concrete is poured. Fit each hanger rod with a nut at its upper

end, and set nut in a universal concrete insert in the form. Where supported weight exceeds holding strength of a single insert, pass rods through top slot of inserts and interlock with reinforcing steel. Also, where particularly heavy loads are to be supported, suspend hanger rod or rods from a structural angle spanning two or more inserts and securely bolted thereto to distribute the weight.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  4. To Existing Concrete: Self-drilling concrete anchors or expansion anchor fasteners.
  5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.
  6. To Light Steel: Sheet metal screws.
  7. For Surface-Mounted Items on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to structure. Attachment to gypsum wall board is not acceptable as sole support means; slotted-channel rack solidly attached to structure or light-gauge metal framing at both ends is required.
  8. For Recessed-Mounted Items in Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices to intermediate light-gauge metal framing members on each side of device or provide slotted-channel racks within hollow wall attached to structure by means that meet anchorage requirements. Attachment to gypsum wall board is not acceptable as sole support means.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars or existing raceways embedded in slab. Verify reinforcing locations with Structural Engineer and X-Ray existing concrete structures as required.
- E. Do not support any items (equipment, piping, conduit, etc.) exceeding 2 inches in diameter from the bottom of slabs. Where intermediate supports are required between structural members, use slotted steel channels support systems attached to beams or joists in order to avoid attachment to slabs.
- F. Slotted Support Systems
1. Install slotted channel systems level and plumb.
  2. Remove burrs from all exposed cut edges prior to installation.
- G. Wall Stud and Ceiling Supports
1. Fasten junction, pull and devices boxes securely to the building construction, independent of raceway system.
  2. Install Device Box Mounting Brackets supported between two studs. Attach all device boxes to two studs, device box stabilizers are prohibited.
  3. Install Tee Bar Grid Box Hanger supported between two ceiling grid tee bars where devices boxes are located flush in recessed suspended ceilings. Install at least one independent support rod from box hanger to structure.
  4. Install Through-Stud Cable and Raceway Support Clips where cables or raceways run horizontally through metal studs.
- H. Install Roof-mounted Raceway Support Blocking where raceways run on across roofing.

1. Coordinate installation of roof supports with items specified in Division 07 Section "Roof Accessories." Provide products compatible with rooftop materials included in the Work to maintain warranty of roof system.
  - I. Threaded Rod Hardware
    1. Provide minimum of two lock nuts per threaded support rod except where lock nut tightens against a threaded socket, one locknut may be used.
    2. Trim rod excess to within 1-inch of locknut, de-burr, and provide protective endcap.
  - J. Support raceways at a distance above suspended ceilings to permit removal of ceiling panels and luminaires.
  - K. Locate raceways and supports so as not to hinder function or code required clearance to any system or equipment.
  - L. Provide independent supports and hang all electrical raceways and devices from the building structure with UL listed and approved materials. Utilizing the support systems of other trade's work is prohibited, except with written approval from the Engineer.
  - M. Provide riser support clamps for vertical conduit runs and install at each floor level penetration and at additional locations required to support weight of system.
  - N. Tighten all bolted connections to proper torque values in accordance with manufacturer's written instructions.
  - O. Provide supports to maintain 1/4-inch air space between raceway and mounting surface where raceways are mounted exposed in wet or corrosive locations and where directly attached to concrete or masonry.
  - P. The use of tie wire or perforated metal tape for support or fastening of any raceway system is prohibited.
  - Q. Where galvanized wire is used for cable supports above suspended ceilings, provide minimum #12 support wire independent of ceiling system secured at both ends. Paint or provide tag to distinguish supports from ceiling system.
  - R. Welding directly on raceways, fittings, or outlet boxes is prohibited.
- 3.5 INSTALLATION OF VIBRATION ISOLATION PADS
- A. Select vibration device load ratings to match equipment loading and deflection criteria.
  - B. Arrange pads in single or multiple layers of sufficient stiffness for uniform loading.
  - C. Install pre-cut segments in accordance with manufacturer recommendations to match shape of equipment base.

### 3.6 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.7 CONCRETE EQUIPMENT BASES

- A. Housekeeping Pads: Construct concrete housekeeping pads a minimum of 4-inches thick and 6-inches larger in both directions than supported unit.
- B. Exterior Equipment Pads: Construct exterior equipment pads a minimum of 8-inches thick and 6-inches larger in both directions than supported unit unless noted otherwise.
- C. Use 4000-psi, 28-day compressive-strength concrete unless otherwise noted. Comply with Division 03 Section "Cast-in-Place Concrete" and ACI standards for subbase requirements, concrete materials, reinforcement, placement, and cover requirements.
  - 1. Reinforce pads with a minimum #4 rebar on 12-inch centers each way or equivalent welded wire fabric. Support reinforcement and tie together to prevent displacement during construction.
  - 2. For interior pads, provide #4 dowels at 24-inch centers each way (minimum of 4) to anchor to structural slab below. Embed dowels into slab a minimum of 3-inches.
  - 3. Provide rubbed finish for all surfaces.
  - 4. Provide 3/4-inch chamfer at all exposed edges.
  - 5. Provide Engineer approved repairs if pad surface is rough or shows signs of honeycomb.
  - 6. Provide crown for exterior pads with a slope of 1/8-inch per foot.
  - 7. Do not set heavy equipment on pad for at least 7 days after pour unless approved by Engineer.
- D. Anchor equipment to concrete base.
  - 1. Locate anchors to be a minimum of 10 bolt diameters from edge of the base.
  - 2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 3. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.8 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.

- B. Coordinate all required openings and provide sleeves and inserts prior to construction of wall and floor systems. Where openings are missed or incorrectly located, provide core-drilling and patching at no additional expense to owner.
- C. Install sleeves without compromising structural integrity of wall or floor.
- D. Sleeves for Conduits or Cable Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  - 2. Unless sleeve seal systems are used, size pipe sleeves to provide a minimum 1/4-inch annular clear space between sleeve and raceway. Where conduit motion due to expansion and contraction will occur, provide sleeves a minimum of two conduit sizes larger than the nominal conduit diameter.
  - 3. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls.
    - a. For conduit penetrations, cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
    - b. For cable penetrations, extend sleeve a minimum of 2-inches beyond surface of wall and provide plastic insulated bushing.
  - 4. Install sleeves for floor penetrations. Extend sleeves installed in floors a minimum of 6-inches above finished floor level unless noted otherwise. Install sleeves during erection of floors.
  - 5. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.
- E. Sleeves for Cables Penetrating Non-Fire-Rated Gypsum Board Assemblies:
  - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 2. Seal space outside of sleeves with approved joint compound or acoustical sealant for gypsum board assemblies.
- F. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units and counter flashing applied in coordination with roofing work. Coordinate all work with roofing system to maintain roof warranty.
- G. Exterior-Wall and Floor Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal system. Size sleeves to allow for manufacturer recommended annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Where sleeves are installed in core drilled openings, grout sleeve into the opening.

- H. Where sleeves are installed exposed in finished spaces, provide metal escutcheon plates of size to match the sleeve.
- I. Sleeve-Seal-System:
  - 1. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
  - 2. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.9 ELECTRICAL SYSTEM FIRESTOPPING INSTALLATION

- A. Install firestopping at all penetrations of fire-rated assemblies. Comply with requirements in Division 07 and as outlined below.
- B. Coordinate location and proper selection of firestop devices with fire rated assembly. Ensure cast-in place devices are installed before placement of concrete.
- C. Install firestop materials in accordance with UL Fire Resistance Directory and manufacturer's instructions.
- D. Affix permanent label to each side of penetration immediately adjacent to firestopping to communicate to futures installers and code authorities the following:
  - 1. Fire-stop product/system used
  - 2. Installation Company
  - 3. Penetration Hour Rating
  - 4. Installation Date
- E. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas. Keep areas of work accessible until inspection by applicable code authorities.

### 3.10 PAINTING

- A. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

## SECTION 260505 - SELECTIVE DEMOLITION FOR ELECTRICAL

### PART 1 - GENERAL

#### 1.1 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

#### 1.2 SUMMARY

- A. This section covers all demolition, restoration, and salvage required to perform the electrical work indicated on the drawings, specified and/or as required to complete the project. It is the intent of this section of work to remove all existing electrical equipment, materials, etc. which are not required for the completed building and to restore any and all finished surfaces to their original type and conditions. To accomplish these requirements, the Contractor(s) shall, at his own expense, engage the services of others already performing finish work on this project. All work shall be completed to the satisfaction of the Architect/Engineers whose decisions shall be final. This requirement shall apply to all restoration work whether indicated or specified.

#### 1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and re-installed.
- B. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, clean and prepare for reuse, and reinstall where indicated.
- C. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed or salvaged, or removed and reinstalled.
- D. Demolish: Completely remove and legally dispose of off-site.
- E. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.
- F. Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner. Include fasteners or brackets needed for reattachment elsewhere.

#### 1.4 SUBMITTALS

- A. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.



- B. Pre-demolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective electrical demolition operations. Submit before the Work begins.

#### 1.5 MATERIALS OWNERSHIP

- A. Except for items or materials to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option but in compliance with ordinances and regulations related to the materials being disposed.

#### 1.6 PROJECT CONDITIONS

- A. Building will be occupied during construction. Localized areas to be demolished will be vacated during demolition work. Conduct selective electrical demolition so Owner's operations will not be disrupted.
- B. Corridors immediately adjacent to the demolition areas will be occupied. Conduct demolition so that access to and between occupied areas will be maintained.
- C. On-site storage or sale of removed items or materials is not permitted.

#### 1.7 COORDINATION

- A. Demolition schedule shall not interfere with Owner's on-site operations and operations of adjacent occupied buildings.
- B. Prior to beginning demolition, arrange a conference with the Construction Representative to review electrical demolition scope, procedures, schedule and items to be salvaged for the Owner.
- C. Review requirements of General Demolition Contractor and work performed by other trades that rely on demolition of electrical circuitry or equipment to allow for structural demolition or removal of equipment.
- D. Review areas where existing electrical circuitry and/or equipment is to remain in place and requires protection.

#### 1.8 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with governing EPA notifications regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

## PART 2 - PRODUCTS

- A. NOT USED

## PART 3 - EXECUTION

### 3.1 EXAMINATION AND RECORDING OF EXISTING CONDITIONS

- A. Contractor is responsible for submitting photos and documenting existing conditions to Owner prior to commencing demolition. Systems and equipment found to be defective after demolition has commenced shall be repaired or replaced by Contractor at no additional cost to Owner.
- B. Notify Construction Representative of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document conditions.

### 3.2 PROTECTION

- A. Comply with governing laws, codes, and regulations governing fire protection and environmental protection during electrical demolition operations.
- B. Existing Utilities: maintain existing utilities and building services and protect from damage during demolition operations.
  - 1. All adjacent areas need to remain in operation and services to other areas outside area of construction need to be maintained during demolition.
  - 2. Disconnect electrical power and communications only to the items of equipment or the panelboard that is identified for removal under the selective electrical demolition scope.
  - 3. Provide temporary services during interruptions to existing utilities or building services as acceptable to Owner and Authorities Having Jurisdiction.
- C. Protect lighting fixtures, exit signs, fire alarm devices, communications devices, etc. that are to remain in place from damage during demolition and construction operations. Exposed fixtures and devices shall have a plastic bag or other suitable covering affixed over the item to protect from dust and paint splatters.
- D. Provide and maintain temporary partitions, dust control barrier, and ventilation per owner's dust control plan.
- E. Temporary enclosures and protection shall be removed by the Contractor upon completion of the electrical demolition work unless otherwise directed by the Construction Representative.

### 3.3 GENERAL REQUIREMENTS

- A. Demolish and remove existing construction in the area of work to the extent required by new construction unless noted otherwise.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.
- C. Where electrical fixtures, equipment or other materials are removed and/or relocated, all abandoned conduit and conductors shall be removed in exposed areas. In concealed areas, materials shall be labeled and abandoned in place or removed as indicated and patch all openings.
- D. The Contractor shall be responsible for the removal and/or relocation of any electrical equipment, fixtures, devices, appurtenances, etc. which may, in the course of construction, interfere with the installation of any new and/or relocated Architectural, Mechanical, Electrical, Structural or Fire Protection Systems whether indicated or not.
- E. Where components of any system in this contractor's scope of work are to be reused, the contractor shall test those components prior to removal and record the state of functionality and condition of the components as tested. These records shall be provided to the owner or engineer upon request. In the absence of these records, all components removed shall be assumed functional at the time of removal. Any device subsequently found to be non-functioning or in unsuitable condition for reuse shall be replaced at the expense of the contractor.
- F. At concealed spaces, such as hollow walls, ducts, and pipe interiors, verify condition and contents of hidden space before starting electrical demolition operations.
- G. All hanger and support material for demolished piping and conduit shall be removed back to the primary structural support member. Grind connection to primary member smooth and touch up with paint to match adjacent surface.
- H. Conduit containing circuits which are to be retained shall remain in place, unless otherwise indicated or required.
- I. Wiring for existing circuits which must be rerouted, or which are partially abandoned, shall be reconnected to service the outlets/loads remaining on the circuit.
- J. All wiring for a circuit which is to be removed or abandoned shall be removed back to the panel which supplied the circuit.
- K. All open conduit knockouts, holes or unused hubs in electrical boxes and enclosures shall be properly plugged with suitable blanking devices that maintain the NEMA rating of the box or enclosure.

### 3.4 PATCHING AND REPAIRS

- A. Unless otherwise indicated, the Contractor shall be responsible for the patching and repairing of all holes, etc. in the ceiling, wall and floors where electrical equipment is removed.

- B. All damages to buildings, utilities, and services to remain in place shall be promptly repaired at no cost to the Owner.
- C. Where an existing utility or building service is interrupted, the contractor shall work continuously, providing premium time, to repair and restore service.
- D. Neatly cut openings and holes plumb, square and true to dimensions, required.
- E. Demolish concrete and masonry in small sections, cutting at junctures with construction to remain.
- F. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
- G. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
- H. All holes or openings in floors, walls or ceilings resulting from electrical demolition shall be properly sealed with material similar to the adjacent surface/finish.
  - 1. Patch holes in concrete floors and ceilings where conduits are removed using non-shrink epoxy grout or concrete material to match existing surfaces and construction.
  - 2. Patch holes in walls and partitions where conduits are removed to match existing construction and finish.
- I. All rough edges of openings created by electrical demolition shall be promptly patched to create a finished surface.
- J. Maintain the fire rating of all floors, walls, partitions and ceilings when patching.

### 3.5 SALVAGED ITEMS

- A. Items noted to be salvaged shall be cleaned, packed or crated with contents identified on the container. The items shall be stored in a secure area until delivery to Owner. Transport items to storage area designated by Owner. Protect items from damage during transport and storage.

### 3.6 RE-INSTALLED ITEMS

- A. Items noted to be removed and re-installed shall be carefully removed, cleaned, and repaired to functional condition adequate for intended reuse.
- B. Pack or crate items after cleaning and repairing with contents identified on the container. Store and protect items from damage.
- C. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment.

- D. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

### 3.7 EXISTING ITEMS TO REMAIN

- A. Protect construction indicated to remain against damage and soiling during selective electrical demolition.
- B. When permitted by Construction Representative, items may be removed to a suitable, protected storage location during selective electrical demolition and reinstalled in their original locations after selective electrical demolition operations are complete.

### 3.8 DISPOSAL

- A. Transport demolished materials off Owner's property and dispose of legally in accordance with Federal, State, and local laws and regulations.
- B. Lamps: Legally dispose of lamps in accordance with EPA guidelines.
  - 1. Contractor shall be responsible for the careful removal of all lamps and fluorescent tubes without breakage from existing lighting fixtures.
  - 2. Lamps removed from fluorescent, metal halide, mercury vapor, and sodium fixtures that do not have green end caps shall be placed by the Contractor in cardboard boxes. The Contractor shall label each box with type and quantity of lamps in each box and seal the box. Boxes shall be properly disposed of.
  - 3. Broken, fluorescent, metal halide, mercury vapor, and sodium lamps without green end caps shall be immediately and carefully cleaned up by the Contractor, placed in a 55 gallon steel drum and properly disposed of by the Contractor

### 3.9 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

END OF SECTION

## SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Building wire and cable rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.
  - 3. Control Voltage Conductors and Cables

#### 1.3 REFERENCES

- A. Abbreviations
  - 1. RoHS: Restriction of Hazardous Substances.
- B. Definitions
  - 1. Low Voltage: Circuits and equipment operating at more than 50VAC but less than 1000VAC for building electrical distribution systems.
  - 2. Control Voltage: Circuits and equipment operating at less than 50VAC for remote-control and signaling power-limited circuits.
  - 3. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
  - 4. Homerun: The run of raceway(s) and cable(s) between the panelboard or switchboard and the junction box in the area served where branch circuit cables originate.
- C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
  - 1. National Electrical Contractors Association (NECA)
    - a. NECA/NACMA 120, "Standard for Installing Armored Cable (Type AC) and Type Metal-Clad (MC) Cable"

#### 1.4 SUBMITTALS

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

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

### 2.2 BUILDING WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Alpha Wire Company.
  - 2. Cerro Wire LLC.
  - 3. Encore Wire Corporation.
  - 4. General Cable Technologies Corporation.
  - 5. Okonite Company.
  - 6. Southwire Company.
- B. Building Wire Description: Flexible, insulated and uninsulated, drawn current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- C. Cable Description: A factory assembly of one or more current-carrying insulated conductors in an overall protective sheath.
- D. General Requirements:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. RoHS compliant.
  - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- E. Copper Conductors: 98% conductive annealed copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- F. Conductor Insulation:
  - 1. 600V, 90°C
  - 2. Comply with ANSI/NEMA WC 70/ICEA S-95-658.
  - 3. THHN/THWN-2: Comply with UL 83.
  - 4. XHHW-2: Comply with UL 44.
  - 5. RHW-2: Comply with UL 44 and UL 2196.
- G. Metal Clad Cable, Type MC
  - 1. Comply with UL1569.

2. Circuits: Single circuit with color coded current carrying conductors and insulated ground conductor.
3. Conductor Insulation: THHN/THWN-2.
4. Armor Jacket: Aluminum Interlocking.
5. Listed for use in through penetration firestop systems.

## 2.3 SPLICING DEVICES & CONNECTORS

- 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. 3M; Electrical Products Division.
  2. AFC Cable Systems, Inc.
  3. Burndy
  4. Gardner Bender.
  5. Hubbell Power Systems, Inc.
  6. Ideal Industries, Inc.
  7. ILSCO.
  8. NSi Industries LLC.
  9. O-Z/Gedney;
  10. Thomas & Betts.
  11. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Material: Tin plated copper
- D. Twist-On Wire Connectors: spring pressure type, 600V, 105°C insulation, capable of connecting two or more wires up to #8 AWG in a pigtail application.
- E. Crimp Sleeve Splices: butt or parallel crimp type, copper sleeve with nylon cover and skirted insulators, capable of permanent connection of two or more wires up to #10 AWG.
- F. Compression Splices: standard or long barrel type, 90°C, with cold shrink tubing, for use with hydraulic crimping tool, capable of permanent connection of wires #6 AWG and larger.
- G. Ring or Flanged Fork Tongue Terminals: crimp type, 600V, 105°C insulation, insulated serrated barrel, capable of terminating wires up to #10 AWG.
- H. No aluminum splicing devices or connectors are permitted.

## 2.4 CONTROL VOLTAGE CONDUCTORS AND CABLE

- A. Control Cable: NFPA 70, Type CMG or CMP
1. Single or Multi-pair, twisted, minimum No. 18 AWG, stranded tinned copper conductors.
  2. PVC insulation.



3. Shielded or Unshielded.
  4. Flame Resistance:
    - a. CMG: Comply with UL1685
    - b. CMP: Comply with NFPA 262
- B. Class 1, 2, and 3 Control Circuits: Stranded Copper, Type THHN/THWN-2

### PART 3 - EXECUTION

#### 3.1 CONDUCTOR AND INSULATION APPLICATION

- A. Feeders and Branch Circuits: Copper. THHN/THWN-2. Solid for #10 AWG and smaller; stranded for # 8 AWG and larger.
1. Provide XHHW-2 insulation for the following:
    - a. Circuits routed exposed on rooftops.
    - b. Conductors on the load side of a Variable Frequency Drive.
- B. Conductors for motors or vibrating or oscillating equipment: Extra flexible stranded.
- C. Conductor sizes indicated on drawings are based upon 75 degree C rating.
- D. Minimum branch circuit or feeder size:
  1. Not less than #12 AWG copper wire unless noted otherwise.
- E. Minimum control circuit conductor sizes:
  1. Class 1 remote-control and signal circuits; No 14 AWG.
  2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
  3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG
- F. Provide all wire for the project in new and undamaged condition. Deliver in standard coils or reels. Wires and cables manufactured more than 24 months prior to date of delivery to the site are not acceptable.

#### 3.2 EXAMINATION

- A. Prior to installing conductors and cables:
1. Verify that raceway installation is complete according to Section 260533 "Raceways and Boxes for Electrical Systems" and ready for installation of conductors and cables.
  2. Verify that raceways are properly sized in accordance with NEC.
  3. Visually inspect exposed raceways to ensure that raceways are not damaged and bends are not deformed.
  4. Verify that raceways do not exceed the maximum number of bends between pull-points.
  5. Verify raceways have been cleaned of all dirt and debris.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

#### A. Pulling Conductors in Raceways

1. Pull cables in accordance with cable manufacturer and pulling equipment manufacturer recommendations as well as applicable sections of the National Electric Code.
2. Use installation equipment, tools, and materials as necessary, such as sheaves, pulling eyes, basket grips, winches, cable reels and/or cable reel jacks, duct entrance funnels, and pulling tension gauges, and approved pulling lubricants where required to facilitate cable pulling without damage to cables or raceway.
3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not use lubricants that harden or become adhesive with age. Apply lubricant where cables enter ducts and conduits and at all intermediate access points on long or difficult pulls.
4. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Utilize special remote readout equipment to ensure compliance.
5. Avoid abrasion and other damage to cables during installation. Provide physical protection of cables, such as using appropriately sized flexible cable guides or feed-in tubes, at the entrance of boxes and raceways.
6. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

#### B. Bend Radius

1. Handle conductors and cables carefully. Make bends in cables and conductors such that cables, conductors, sheaths, armor, etc., are not damaged.
2. Do not bend conductors and cables to less than the NEC and manufacturer recommended minimum bending radius.
3. Ensure that tools and accessories used to install conductors and cables, such as rollers, sheaves, trolley assemblies, tube guides, and/or raceways, are properly sized and utilized to be greater than the minimum bending radii of conductors and cables.
4. Minimize bending where conductors and cables enter or exit raceways, cabinets, and boxes. Do not install cables that have been bent or kinked to a radius less than the recommended dimension.
5. Install conductors only after insulating bushings are in place.

C. If multiple circuits are pulled in a single homerun, provide a dedicated neutral for each phase conductor. In these cases, a maximum of seven conductors (six current carrying and one ground) are permitted in a single conduit except for switch legs and travelers in multi-point switching arrangements. De-rate conductors per NEC.

D. Multi-wire branch circuits with a shared neutral are not permitted unless specifically noted on the drawings. Where indicated, group the phases and neutral together with cable ties in the panelboard and in all pull boxes.

E. Install conductors for isolated power systems in as short a run of conduit as practicable. The use of pulling compound or lubricant is not permitted on conductors in isolated power systems.

F. Voltage Drop:

1. Adjust conductors and conduit sizes accordingly based on actual field installed conditions.
  2. Size and Install all feeders and branch circuits for a maximum 2% voltage drop in feeders and 3% in branch circuits with a maximum total voltage drop of 5%.
  3. Calculate using a load equal to 80% of the supply breaker rating unless the circuit breaker is rated to carry 100% of the load.
  4. Where the conductor length from the panel to the first outlet on a circuit exceeds the values below, adjust branch circuit conductors from the panel to the first outlet. Increase the conductor size of remaining branch circuit as needed to meet above voltage drop limitations.
    - a. For 277VAC homeruns exceeding 125-feet, #10 AWG minimum
    - b. For 120VAC homeruns exceeding 50-feet, #10 AWG minimum
    - c. For 120VAC homeruns exceeding 100-feet, #8 AWG minimum
- G. Aluminum Conductors
1. The use of aluminum conductors is not permitted.
- H. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- I. Install cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours.
- J. Bundle cables where run in groups using listed supports. Provide independent supports directly from structure, do not route through structure or on work of other trades.
- K. Metal Clad Cable, Type MC
1. The use of metal clad cable is not permitted, except for connections to ceiling mounted recessed and semi-recessed luminaires concealed in accessible ceiling where the maximum length is limited to 72-inches.
  2. Where MC cable is permitted, comply with the following:
    - a. Install MC cables and connectors in accordance with NECA/NACMA 120.
    - b. Use only for single-circuit applications. For devices in the same wall connected to different circuits, install separate single circuit cable for each circuit.
    - c. Support MC cables with clamps, clips, or similar product specifically designed for supporting cables in accordance with NEC and route all runs parallel or perpendicular to building lines with right angle turns complying with manufacturer's bend radius requirements.
    - d. Cables shall be bundled where run in groups using listed supports to maintain proper spacing. Where spacing can't be maintained, apply adjustment factors for derating conductors.
    - e. Do not route through structure or on work of other trades. Provide independent supports directly from structure.
- L. Control Circuit Conductors and Cables
1. Use insulated spade lugs for wire and cable connection to screw terminals.
  2. Conductors installed within environmental air plenums shall be per NEC. Article 800 and other applicable codes, with FEP-type insulation or an approved equivalent. Provide

plenum-rated cable supports where plastic straps or other supports, etc., are installed in plenum areas.

3. Where indicated, systems and control conductors that are installed exposed shall not be routed across ceilings or ductwork. Provide independent supports anchored to building structure or other permanent support members.
4. Install in such a manner as to not interfere with the access to or operation of equipment or removal of ceiling tiles.
5. Nylon tie-wraps shall be installed in such a manner so as to bundle conductors neatly, allowing runouts of single conductors or groups to drop down to equipment served.
6. Install grommets where dropping out of trays or into panels or service columns.
7. Install sleeves with bushings where penetrating partitions.
8. Provide firestopping for penetrations of fire rated assemblies with approved materials.

### 3.4 SPLICES, TAPS, CONNECTIONS, AND TERMINATIONS

- A. Prepare cable in accordance with the conductor, cable, splice and termination component manufacturers' recommendations and instructions.
- B. Cut conductors and cables using tools and methods which ensure a square cut. Do not nick or damage conductors.
- C. Ensure conductor inserts fully into the connector or termination with the insulation fitting closely to the connector or termination.
- D. 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. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, a calibrated torque tools shall be used to achieve that indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.
- E. Splices and Taps
  1. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
  2. Make splices and taps in junction boxes or other enclosure approved for the wiring method.
  3. For conductors #10 AWG and smaller conductors, use pressure crimp type connections.
  4. For conductors #8 AWG and larger, use a hydraulic compression type connection, with cold shrink tubing and tape to restore full insulation value of the wire being spliced.
- F. Connections and Terminations
  1. Ensure that conductor temperature and ampacity ratings are compatible with connectors, terminals, and equipment to which they are to be connected.
  2. Provide crimp-applied ring or flanged fork type terminals for motor and equipment terminals where such terminals are provided on motor and equipment leads or on all stranded wire terminations using #10 AWG or smaller conductors.
  3. Motor Connections shall use connection lugs with motor stub splice insulators.

- G. Wiring at Outlets: Install conductors at each outlet with at least 12 inches of slack.
- H. All cables and wiring, regardless of voltage, installed in manholes or cable vaults shall be routed in such a manner to provide a minimum of 10 feet of slack cable for future splicing. Install cables along walls by utilizing the longer route from entry to exit. If both routes are symmetrical, provide a loop of cable secured to wall. All cables shall be tied to insulated cable supports on wall-mounted racks, spaced a maximum of three feet apart.

### 3.5 PROTECTION

- A. Intentional or unintentional painting of exposed low-voltage and/or control-voltage cabling insulation is prohibited. Ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades.
- B. Review the project's painting requirements for all disciplines and provide protection as required.
- C. Where exposed cabling is being installed in exposed ceiling or wall spaces that are required to be painted, provide cabling in enclosed raceways or provide alternate options for cable colors to engineer for approval.

### 3.6 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
  - 1. All conductors shall be identified by means of labels placed on conductors in all junction boxes and at each terminal point with labels indicating source, circuit number or terminal number.
  - 2. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.
  - 3. Identify each control voltage conductor or cable on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.
- B. Conductors, in all sizes of cable, shall have continuous solid insulation color(s) from the manufacturer. Taped ends shall not be acceptable.
  - 1. Conductors shall be color coded as follows:
    - a. 120/208 Volt Conductors
      - 1) Phase A: Black
      - 2) Phase B: Red
      - 3) Phase C: Blue
      - 4) Neutral: White
      - 5) Ground: Green
    - b. 277/480 Volt Conductors
      - 1) Phase A: Brown
      - 2) Phase B: Orange
      - 3) Phase C: Yellow
      - 4) Neutral: Gray or White with Brown tracer

- 5) Ground: Green
2. Control voltage wiring color coding shall be consistent throughout the project and shall match existing equipment and standards where applicable. Color coding for each system shall be unique.
3. Conductors within enclosures that may be energized when enclosure disconnect is off - yellow, or taped with 1/2" yellow tape every 6" of length, inside enclosure. Provide lamacoid plate warning sign on front of enclosure where this condition occurs.

### 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Visual Inspections:
  1. Compare cable data with drawings and specifications.
  2. Inspect exposed sections of cable for physical damage and correct connections in accordance with drawings.
  3. Inspect bolted electrical connections for high resistance. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
  4. Inspect compression-applied connectors for correct cable match and indentation.
  5. Inspect for correct identification and arrangements.
  6. Inspect cable jacket insulation and condition.
- C. Electrical Tests:
  1. Perform insulation resistance testing for all electrical distribution system feeders unless notes otherwise. Testing may be witnessed by the Engineer and/or Commissioning agent. Schedule all tests with Architect with sufficient notice.
  2. Insulation resistance tests shall be performed at a DC voltage of 1,000 volts for 600 volt rated equipment, and at a DC voltage of 500 volts for 120-300 volt rated equipment. Test duration shall be one minute. Minimum acceptable (temperature corrected) resistance is 25 megaohms for 120-300 volt rated equipment and 100 megaohms for 600 volt rated equipment and wiring.
  3. Test instruments shall be calibrated to national standards within the last 12 months.
- D. Test and Inspection Reports: Prepare a written report to record the following:
  1. Test procedures used.
  2. Results that comply with requirements.
  3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Cables will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.
- F. Submit test results to Architect and Engineer for approval

END OF SECTION

## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 “General Requirements for Electrical Systems” apply to this Section.

#### 1.2 SUMMARY

- A. Description: Grounding and Bonding for electrical systems covers several different but interrelated systems including Electrical System Grounding, Equipment Grounding System, Grounding Electrode System, and interfaces with telecommunications bonding infrastructure as well as lighting protection systems.

#### 1.3 REFERENCES

- A. Definitions
  - 1. Grounding: Establishing a direct or indirect connection to Earth or some conducting body that serves in place of Earth.
  - 2. Bonding: Method by which all non-energized conductive materials are effectively interconnected to create a low impedance path.
- B. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
  - 1. National Electrical Contractors Association (NECA)
    - a. NECA 331 – Standard for Building and Service Entrance Grounding and Bonding

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
- B. Comply with NFPA 70 and UL 467 for grounding and bonding materials and equipment.

## 2.2 MANUFACTURERS:

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

1. ABB Blackburn
2. Eaton B-Line
3. Harger
4. Hubbell Burndy
5. IlSCO
6. nVent Erico
7. Panduit
8. VFC Lyncole

## 2.3 CONDUCTORS

- A. Insulated Copper Conductors: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables".
- B. Straps/Jumpers: Copper tape, braided conductors pre-terminated with copper ferrules, cross-sectional area no less than a No. 6 AWG conductor.

## 2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Irreversible Compression Connectors: Tin-plated copper, for installation using a hydraulic compression tool and die matched to connector type. Provide with die code or other visual indicator to ensure proper connector selection and uniform compression for a permanent connection.
1. Taps: C-type, H-type, or Figure 6/8 type.
  2. Splices: Long Barrel straight or tee.
  3. Terminals: Two-hole lug long barrel type.
- C. Mechanical Connectors: Tin-plated high strength copper alloy or high strength cast bronze
1. Water Service Pipe Clamps: Heavy-Duty, two-piece saddle type with stainless steel bolts.
  2. Pipe Clamps: Heavy-Duty, U-bolt type with silicon bronze hardware.
  3. Lay-in Lug Connector: Heavy-Duty, open face lug with hex head set screw.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Bond grounding bus and all non-current carrying metallic parts of raceways systems and equipment to common ground in accordance with the National Electrical Code, NECA 331, as



shown on the Contract Drawings, and in accordance with the requirements of the local authority having jurisdiction.

- B. The size of the grounding and bonding conductors shall be not less than that given in Article No. 250 of the National Electrical Code, and/or as shown on the Contract Drawings.
- C. Interconnect all grounding systems in or on the structure to provide a common ground potential.
- D. Bond all outlet, junction, pull boxes, and enclosures to the equipment grounding conductor with a grounding pigtail.

### 3.2 APPLICATIONS

- A. Conductors: Install solid conductor for #10 AWG and smaller, and stranded conductors for #8 AWG and larger unless otherwise indicated.
  - 1. Provide insulated conductors not exceeding No. 8 AWG in size with green colored insulation. Identify conductors larger than No. 6 AWG with 4-inch green tape at each termination and at all junction and pull boxes.

### 3.3 EQUIPMENT GROUNDING AND BONDING

- A. Equipment Grounding Conductors: Install insulated equipment grounding conductors with all feeders and branch circuits. Provide conductors of the same wire/cable type as the ungrounded current carrying conductors.
- B. Increase equipment grounding conductor sizes in accordance with NEC article 250 where ungrounded current carrying conductor sizes are increased to minimize voltage drop.
- C. Provide all circuits with a dedicated equipment grounding conductor unless noted otherwise.
- D. At all metallic outlet, junction and pull boxes, bond the equipment grounding conductor to the enclosure.

### 3.4 INSTALLATION

- A. Grounding Electrode Conductors and Bonding Jumpers: Securely fasten and route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
  - 1. Route conductors to maintain a downward or horizontal direction to ground with a minimum bend radius of 8-inches.
  - 2. Protection: Install above grade conductors No 6 AWG or larger exposed to physical damage and all conductors smaller than No. 6 AWG in schedule 80 PVC conduit. Where metallic conduit is required, bond each conduit end to the electrode or ground conductor as close to the openings as possible with a full-size conductor and bonding bushing to create an electrically parallel path.

3. Clearance: Maintain a minimum separation of 12-inches from open telecommunications cable groups.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts. Install straps and jumpers such that it does not restrict movement of the structure to which it is connected.
  2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- C. Mechanical Connections: Install mechanical connections in accessible locations.
1. Tighten connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values.
  2. 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.
- D. Connections between Dissimilar Metals: 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.
1. Clean surfaces and apply anti-oxidant compound prior to installation of connections.
  2. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  3. Make connections with clean, bare metal at points of contact.
  4. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  5. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

### 3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  2. After completing installation of the grounding electrode system and finished grade, but before permanent electrical circuits have been energized, test for compliance with requirements.

END OF SECTION

## SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 – General Requirements for Electrical Systems apply to this Section.

#### 1.2 SUMMARY

- A. This section is intended to specify the raceways, fittings, boxes, cabinets, specialties and related items necessary to complete the work as shown on the drawings and specified herein.
- B. Section Includes:
  - 1. Metal conduits and fittings
  - 2. Nonmetallic conduits and fittings
  - 3. Metal wireways and auxiliary gutters.
  - 4. Boxes, enclosures, and cabinets
- C. Related Requirements:
  - 1. Refer to Division 07 firestopping section and Section 260010 “General Requirements for Electrical Systems” for penetration firestopping requirements related to electrical pathways and boxes.

#### 1.3 REFERENCES

- A. Abbreviations
  - 1. EMT: Electrical Metallic Tubing
  - 2. FMC: Flexible Metal Conduit
  - 3. GRC: Galvanized Rigid Steel Conduit
  - 4. IMC: Intermediate Metal Conduit
  - 5. LFMC: Liquid-tight Flexible Metal Conduit.
  - 6. RAC: Rigid Aluminum Conduit
  - 7. RMC: Rigid Metal Conduit
- B. Definitions
  - 1. Outlet: A point on the wiring system at which current is taken to supply utilization equipment.
  - 2. Raceway: an enclosed channel designed for enclosing and protecting electrical, communications, and signaling wires and cables.

- C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
1. National Electrical Contractors Association (NECA)
    - a. NECA 101 - Standard for Installing Steel Conduits (RMC, IMC, EMT)
    - b. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)
  2. National Electrical Manufacturers Association (NEMA)
    - a. NEMA FB 2.10 - Selection and Installation Guidelines for Fittings for Use with Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing)
    - b. NEMA FB 2.20 - Selection and Installation Guidelines for Fittings for Use with Flexible Electrical Conduit and Cable
    - c. NEMA RV 3 - Application and Installation Guidelines for Flexible and Liquid-tight Flexible Metal Conduits

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

### 2.2 METAL CONDUIT AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. AFC Cable Systems, Inc.
  2. Allied Tube & Conduit.
  3. Anamet Electrical, Inc.
  4. Calconduit
  5. Electri-Flex Company.
  6. Nucor Tubular Products.
  7. O-Z/Gedney.
  8. Picoma Industries.
  9. Robroy Industries.
  10. Southwire Company.
  11. Thomas & Betts Corporation.
  12. Western Tube and Conduit Corporation.
  13. Wheatland Tube Company.
- B. Electrical Metallic Tubing (EMT) and Elbows:
  1. Comply with ANSI C80.3 and UL 797.

- C. Galvanized Rigid Steel Conduit (GRC, RMC) and Elbows:
  - 1. Comply with ANSI C80.1 and UL 6.
  - 2. Zinc coating both inside and outside by means of hot-dip galvanizing.
  - 3. Use only threaded fittings for GRC.
  
- D. Intermediate Metal Conduit (IMC) and Elbows:
  - 1. Comply with ANSI C80.6 and UL 1242
  
- E. Flexible Metal Conduit (FMC):
  - 1. Comply with UL 1.
  - 2. Continuous interlocked hot-dip zinc galvanized steel with smooth interior and exterior.
  - 3. Suitable for dry locations.
  
- F. Liquid-tight Flexible Metal Conduit (LFMC):
  - 1. Comply with UL 360.
  - 2. Continuous interlocked hot-dip zinc galvanized steel core with smooth interior and exterior.
  - 3. Suitable for wet and dry locations, direct burial applications, and concrete encasement.
  - 4. Sunlight resistant, flame retardant thermoplastic PVC jacket resistant to heat, oil, and chemical breakdown.
  
- G. Metal Fittings
  - 1. Comply with NEMA FB1 and UL 514B.
  - 2. Listed and labelled for type of conduit, location, and use.
  - 3. Fittings for EMT:
    - a. Compression type, zinc-plated galvanized steel.
    - b. Concrete-tight- or rain-tight, hardened steel locknuts, and nylon insulating throats.
  - 4. Fittings for GRC and IMC:
    - a. Threaded zinc plated steel.
    - b. Concrete-tight- or rain-tight, nylon insulating throats.
  - 5. Conduit Bodies:
    - a. Material: gray iron or heavy copper-free cast aluminum
    - b. Available in varying configurations with integral bushing and gasketed coverplate.
  - 6. Expansion/Deflection Fittings: UL 651 listed, manufactured coupling accommodating 3/4-inch linear movement from normal and 30-degree angular movement in all directions
    - a. Basis of Design: OZ/Gedney DX
    - b. PVC or steel sleeve to match conduit type with neoprene jacket, rated for environmental conditions where installed.
    - c. Integral braided copper bonding jumper.
  - 7. Fittings for FMC and LFMC:
    - a. LFMC: Tubular Steel, zinc-plated with gland nut, sealing ring, high tensile grounding ferrule, insulated throat, and body for liquid tight connection.
  - 8. Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
  - 9. "Kwik-Couple" type fittings are not permitted.
  - 10. Indentation, set-screw, or die-cast fittings are not permitted.

- H. Joint Compound for threaded conduit: UL 2419 listed for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

### 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- 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. Eaton B-Line
  - 2. Hubbell Wiegmann.
  - 3. nVent Hoffman.
  - 4. Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise required by environmental application, and sized according to NFPA 70. Minimum of 14-gauge steel before finishes are applied.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.
  - 1. Provide knockouts on all runs, unless otherwise indicated or prohibited by codes.
  - 2. Provide dividers to separate conductors of different insulation levels or where required by equipment vendor installation instructions.
- D. Wireway Covers: Furnish with continuous hinged covers on all runs and removable covers on all fittings unless otherwise noted, to allow a continuous unobstructed path for conductor installation.
- E. Finish: Manufacturer's standard enamel finish resistant to corrosion, moisture, and oil.
- F. Size: available in nominal sizes 2-1/2-inch by 2-1/2-inch, 4-inch by 4-inch, 6-inch by 6-inch or 12-inch by 12-inch.
- G. Install supports to allow unobstructed access to wireway interior. Use minimum 1/4-inch rod hangers for up to 4-inch by 4-inch wireway, 3/8-inch rod up to 8-inch by 8-inch wireway, and 1/2-inch rod for 12-inch by 12-inch wireway.

### 2.4 BOXES, ENCLOSURES, AND CABINETS

- 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. Eaton Crouse-Hinds.
  - 2. Emerson/Appleton Electric.
  - 3. FSR Inc.
  - 4. Garvin Industries
  - 5. Hoffman.
  - 6. Hubbell Killark.

7. Milbank Manufacturing Co.
  8. Mono-Systems, Inc.
  9. O-Z/Gedney.
  10. RACO / Hubbell.
  11. Stahlin Non-Metallic Enclosures.
  12. Thomas & Betts.
  13. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed for intended use.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.
- E. Luminaire Outlet Boxes: Non-adjustable, designed for attachment of luminaires, listed and marked for the maximum allowable weight with at least a 2.0 safety factor for the anticipated fixture weight.
- F. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, constructed of code gauge, galvanized steel with sides formed and corner seams riveted or welded before galvanizing
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- I. For box extensions and mud rings used to accommodate building finishes, provide with same material as recessed box.
- J. Minimum Device Box Dimensions unless noted otherwise:
1. Single gang: 4-inches square by 2-1/8-inches deep with single gang extension ring.
  2. Two gang: 4-inches square by 2-1/8-inches deep with two-gang extension ring.
  3. Three gang: 8-5/8-inches by 4-1/2-inches by 2-1/2-inches deep with three gang extension ring.
  4. Four gang: 10-7/16-inches by 4-1/2-inches by 2-1/2-inches deep with four gang extension ring.
- K. Gangable boxes are prohibited.
- L. Boxes assembled with sheet metal screws are prohibited.
- M. Hinged Cover Enclosures: Comply with UL 50 and NEMA 250, suitable for installed environment with continuous-hinge cover and flush latch unless noted otherwise.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  2. Nonmetallic Enclosures: Fiberglass
  3. Interior Panels: Steel, all sides finished with manufacturer's standard enamel.

### PART 3 - EXECUTION

#### 3.1 RACEWAY APPLICATION

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.
- B. Apply raceway products as specified below unless otherwise indicated:
1. Exterior and Exposed: GRC
  2. Interior, Concealed in Ceilings, Walls, and Partitions: EMT, IMC, or GRC
  3. Interior, Concealed in Concrete or Grouted Masonry Walls and Partitions: IMC or GRC
  4. Interior, Damp or Wet Locations: GRC
  5. Interior, Where exposed and Not Subject to Physical Damage: EMT, GRC, or IMC. Raceway locations include the following:
    - a. Electrical Rooms
  6. Interior, Where Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms (below 8'-0").
    - d. Gymnasiums.
  7. Boxes and Enclosures: NEMA 250, Type 1 except as follows:
    - a. Damp or Wet locations: NEMA 250, Type 3R
    - b. Commercial/Institutional Kitchens and Cafeterias: NEMA 250, Type 3R
    - c. Corrosive environments: NEMA 250, Type 4X
  8. Non-metallic conduit is not permitted for the following applications unless approved by the Engineer:
    - a. Interior Locations including environmental air plenums.
    - b. Applications where a redundant ground fault path is required by code.
  9. Flexible non-metallic conduit is not permitted.
- C. Minimum Raceway Size: 3/4-inch trade size unless noted otherwise on the drawings.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
  4. Flexible Conduit: Use only steel fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth or where prolonged contact with construction materials will degrade the aluminum.



- F. Install raceways and fittings in a manner to avoid use of dissimilar metals that would result in galvanic action corrosion.
- G. Install surface conduits or raceways only where indicated on Drawings.
- H. Do not install surface conduits or raceways on exterior facades unless approved by Engineer.
- I. Do not install nonmetallic conduit where ambient temperature or operating temperature of the conductors exceeds the rating of the raceway.
- J. Conduit installed embedded in concrete slabs is not permitted.

### 3.2 RACEWAY INSTALLATION

- A. Comply with requirements in Section 260500 "Common Work Results for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1, NECA 101, NECA 111 and manufacturer's written instruction for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with utility company requirements for raceways and boxes containing utility company conductors.
- E. Size raceways to conform with Annex C, of the National Electrical Code, unless otherwise shown on the Contract Drawings.
- F. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure wherever possible, to maximize available space and not restrict other trades.
- G. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated.
- H. Install conduits with runs parallel or perpendicular to building lines, walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends unless otherwise shown. Randomly routed conduits are not acceptable.
- I. Make bends in raceway using large-radius preformed elbows. Provide concentric bends for parallel runs of conduit. Conform with NFPA 70 minimum radii requirements for field bending. Use only equipment specifically designed for material and size involved.
- J. Install no more than the equivalent of three 90-degree bends in any conduit run. Support within 12-inches of changes in direction.
- K. Provide junction boxes or pull boxes so that conduit runs do not exceed 100 feet, or as shown on the Contract Drawings. Size junction boxes per NEC, Article 370.

- L. Provide conduit supports spaced not more than 8-feet apart.
- M. Support conduit within 12-inches of enclosures to which attached.
- N. Do not drill into bar joists to support raceways or cables.
- O. Install conduits at least 12-inches away from flues, steam or hot water pipes.
- P. Conduit installed under concrete slabs is permitted for feeders and for branch circuits serving floor outlets. Underslab conduit is prohibited for other locations unless noted on the drawings or with permission of the engineer. Where approved, comply with the following:
  - 1. Locate raceway a minimum of 12-inches below the bottom of slab.
  - 2. Provide minimum 2-inch spacing between conduits to ensure proper compaction of structural fill.
  - 3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  - 4. Transition underslab RNC to GRC for all bends larger than 20-degrees and for all stub-ups through a slab on grade. Arrange stub-ups so curved portions of bends are not visible above finished slab. Extend GRC stub-ups a minimum of 6" above the concrete slab. Schedule 80 PVC stub-ups are allowed where approved by engineer.
  - 5. Seal around conduits when penetrating vapor barriers.
- Q. Where raceways are subject to environmental changes, locate seals immediately at the boundary so no fittings or boxes are between the seal and the change of environments that would allow migration of condensation within the raceway system. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from cold to warm locations, such as boundaries of refrigerated spaces and at building wall and roof penetrations.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Conduit extending from interior to exterior of building.
  - 4. Conduit extending into pressurized duct and equipment.
  - 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  - 6. Where otherwise required by NFPA 70.
- R. Install conduits in a manner so as to ensure against collection of trapped condensation. Arrange all runs of conduit so as to be devoid of traps. Provide trapped conduit runs with explosion proof drains at low points.
- S. At hazardous locations, install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed non-shrink sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
- T. Coordinate with other trades, including metal and concrete deck trades, as necessary to interface installation of electrical raceways and components.
- U. Complete installation of electrical raceways before starting installation of cables or wires within raceways.

- V. Take precautions to prevent the lodgment of dirt, plaster, or trash in all conduit or tubing, fittings and boxes during construction. Use mandrel to clean all conduit for floor boxes or conduit below grade and ensure its swabbed free of debris or moisture before wiring is installed.
- W. Unless using GRC, do not locate conduits, cables, raceways, and enclosures within 2 inches of bottom of metal-corrugated sheet roof decking, measured from the lowest surface of the roof decking to the top of the conduit, cable, raceway, or box.
- X. Conduits, cables, raceways, and enclosures are not permitted in concealed locations of metal-corrugated sheet decking type roofing.
- Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72-inches of flexible conduit for ceiling mounted recessed and semi-recessed luminaires, and 36-inches for all other equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Install as a single piece with clamp-on insulated throat connectors designed for the purpose.
  - 2. Provide strain relief fittings where subject to vibration.
  - 3. Provide an equipment grounding conductor and bonding jumper at all locations.
  - 4. For LFMC, provide a minimum of 18-inches and loop to avoid restraining vibrating equipment.
- Z. Stub-ups to Accessible Ceilings:
  - 1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or into an enclosure.
  - 2. Where conduits terminate at a cable tray pathway, provide listed fitting to secure conduit to cable tray.
- AA. Mechanically fasten conduit terminations at a wireway, provide metal insulated bushings, and bond to the wireway with bonding jumper.
- BB. Furnish conduit bodies in proper configurations, avoiding excessive openings. Any openings that are left shall be properly plugged. Wiring splices within conduit bodies are not permitted.
- CC. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- DD. Provide a completely separate raceway system, including junction boxes and pull-boxes, for each emergency power, optional stand-by, and normal power system for complete separation in accordance with NEC.
- EE. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of secured slack at each end of pull wire. Secure pull string at each end and cap raceways.
- FF. Coordinate with vendors and provide extra pull-strings as required to ensure sufficient number of pull strings.

- GG. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
- HH. Raceway Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines
1. Install raceways square to enclosures and terminate with appropriate fitting:
  2. For enclosures without hubs, terminate with appropriate fitting, insulated throat liner, and case-hardened locknuts on both sides of enclosure wall.
  3. Terminate rigid conduits with threaded hubs or with locknuts on inside and outside of enclosure and insulated throat metal bushing.
  4. Install locknuts hand tight, plus one-quarter turn more.
  5. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
  6. All threaded fittings shall engage a minimum of seven full threads. Fasteners shall be properly torqued to manufacturer's recommendations.
  7. Split sleeve insulators are not permitted.
- II. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- JJ. Expansion-Joint Fittings:
1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- KK. Where raceways penetrate rooms or walls with acoustical requirements, seal raceway openings on both sides of penetration with acoustically rated putty or sealant.

### 3.3 BOX AND ENCLOSURE INSTALLATION

- A. Provide electrical outlets and enclosures as required for splices, taps, wire pulling, and equipment connections.
- B. Provide pull boxes as required to maintain conduit run and bend limitations specified herein.
- C. Size all outlets, pull boxes, junction boxes, cabinets, etc., per adopted edition of the National Electrical Code.
- D. Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- E. Install interior and exterior outlet boxes recessed in building construction with face or cover flush with finished surfaces unless noted otherwise. Where outlet boxes are installed in walls of glazed tile, brick, concrete block, or in walls covered by wood wainscot or paneling, provide deep box to ensure the outlet boxes are installed straight and secure in walls.

- F. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements and architectural elevations. Install boxes with height measured to center of box unless otherwise indicated.
- G. Locate boxes so that cover or plate does not span different building finishes.
- H. Provide spanner bars to support all boxes from more than one side by spanning two framing members.
- I. Fasten boxes up to 4-11/16 square size to their mounting surface or support with two fasteners of proper size. Fasten larger sizes with four fasteners, minimum.
- J. Support boxes recessed in ceilings independent of ceiling tiles and ceiling grid.
- K. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits or ceiling support wires.
- L. Provide all cabinets and boxes for NEMA 1 applications with knockouts, as necessary, or field cut with approved cutting tools which will provide a clean, symmetrically cut opening to maintain UL listing of enclosure.
- M. Replace any unused knockouts or openings with a listed knockout closure.
- N. Coordinate with equipment vendors to provide special sized outlet boxes to support installed equipment.
- O. Where boxes and enclosures are located in areas or on walls with acoustical requirements, seal openings and knockouts in back and sides of boxes with acoustically rated putty or sealant and provide gasket for wall plates and covers.

### 3.4 GROUNDING AND BONDING

- A. Bond all metal boxes, junction boxes and pull boxes with pigtailed to the equipment grounding conductor.
- B. Provide insulated throat grounding bushings with appropriately sized bonding jumpers for the following locations to maintain electrical continuity between the raceway and enclosure:
  - 1. Metal raceways and enclosures that contain service conductors.
  - 2. Metal raceways and enclosures that contain grounding electrode conductors.
  - 3. Where metal raceways containing circuits over 250V terminate in a concentric or eccentric knockout at cabinets, enclosures, or sheet metal pull boxes listed in accordance with UL 50.
  - 4. Where the integrity of a concentric or eccentric knockout has been compromised.

### 3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.
- B. Protect threads on conduits and fittings with plastic protectors or other means to prevent damage prior to installation.
- C. Provide protection for all conduit stubbed through floor during construction with plastic caps approved for this purpose.

### 3.6 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify all junction, outlet and pull boxes in data/mechanical/electrical rooms and above ceilings with panel and circuit designation on outside of covers. Identify all exposed junction, outlet and pull boxes in finished areas with panel and circuit designation on inside of covers.

### 3.7 PAINTING

- A. Raceways installed in exterior locations shall receive one coat of primer, two coats finish paint after preparation of galvanizing, color selected by Architect.
- B. Exposed raceways in painted interior areas shall be painted to match adjacent finishes.

END OF SECTION

## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment Nameplates.
  - 2. Cable and Conductor Labels.
  - 3. Wiring Device Labels
  - 4. Safety Labels.
  - 5. Instruction Signs.
  - 6. Miscellaneous identification products.

#### 1.3 REFERENCES

- A. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
  - 1. American National Standards Institute (ANSI)
    - a. ANSI Z535.4, "Product Safety Signs and Labels"
  - 2. National Fire Protection Association (NFPA)
    - a. NFPA 70E, "Standard for Electrical Safety in the Workplace"
  - 3. Occupational Safety and Health Administration (OSHA)
    - a. 29 CFR 1910.144, "Safety color code for marking physical hazards"
    - b. 29 CFR 1910.145, "Specifications for accident prevention signs and tags"
  - 4. Underwriters Laboratories Inc (UL)
    - a. UL 969, "Marking and Labeling Systems"

#### 1.4 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
  - 1. Include project specific examples of each label type.

- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Closeout Submittal:
  - 1. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
    - a. Provide electronic Excel files of all panelboard directories to owner as part of Close-out Documentation.

## 1.5 COORDINATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes and standards. Use consistent designations throughout Project.
- B. All identifications shall be consistent with the owner's standard practices, especially within existing facilities, unless otherwise require by codes. Where the requirements herein are in conflict, the contractor shall notify the engineer in writing prior to ordering any material.
- C. All room names and/or numbers for labeling or programming shall use the Owner's approved room name and numbering scheme, not names and numbers indicated on floor plans. All reprogramming shall be included as required to accommodate construction phasing.
- D. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- E. Coordinate installation of identifying devices with location of access panels and doors.
- F. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT SIGNS AND NAMEPLATES

- A. Engraved Plastic Signs and Nameplates.
  - 1. 3-layer melamine plastic laminate
  - 2. Weather and UV-resistant for Wet and Damp Locations.
  - 3. Thickness:
    - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
    - b. For signs larger than 20 sq. in. or 8 inches in length, 1/8 inch thick.
    - c. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
    - d. Framed with mitered melamine molding and arranged for attachment at applicable equipment.



4. Color: Comply with color legend.

## 2.2 RACEWAY AND CONDUCTOR LABELS

- A. Raceway Labels: Pre-printed, self-adhesive, polyester, suitable for indoor or outdoor use, resistant to abrasion, humidity, and weather.
  1. Color: Black Letters on an orange field.
  2. Size: For each raceway size, comply with ANSI/ASME A13.1 for recommended letter height and field length.
- B. Wire and Cable Labels: Machine printed, self-adhesive, polyester, self-laminating, suitable for indoor or outdoor use on flexible cables, resistant to abrasion, humidity, and weather.

## 2.3 SAFETY SIGNS AND LABELS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. All field-applied hazard markings shall warn of hazards using effective words, colors, symbols, or any combination thereof as recommended by ANSI Z535.4-2011. This applies to all instances where caution, warning, or danger signs are required per the NEC and applicable OSHA standards.
- C. Self-Adhesive Safety Labels: Polyester, Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for intended use and suitable for installed environment.
- D. Provide UV overlaminating film for outdoor locations.

## 2.4 INSTRUCTION SIGNS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

## 2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Floor Marking Tape: 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.
- B. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system suitable for surface material and location (exterior or interior).
- C. Fasteners for Labels and Signs:

1. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.
  2. Pop-Rivets.
  3. Two-Part Epoxy Adhesive
- D. Cable Ties: Self-extinguishing, one-piece, self-locking, UV-stabilized or plenum rated where required by installed environmental conditions. 3/16-inch minimum width.

## PART 3 - EXECUTION

### 3.1 GENERAL REQUIREMENTS

- A. Verify identity of each item before installing identification products.
- B. Before installation of labels, clean all surfaces using materials and methods recommended by manufacturer of identification device.
- C. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- D. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- E. Install all labels in a neat manner, plumb and parallel to equipment lines.
- F. Attach plastic signs and labels to equipment with mechanical fasteners appropriate to the location and substrate. Where screws cannot or should not penetrate substrate use two-part epoxy adhesive listed for use with intended substrate and environmental conditions.
- G. Hand written, non-permanent, or stenciled labels are not permitted unless noted otherwise.
- H. For surfaces that require finish work, apply identification devices to surfaces after completing finish work.
- I. Identification shall consist of all UPPER-CASE LETTERS.
- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

### 3.2 EQUIPMENT IDENTIFICATION

- A. Provide all new and modified equipment with a nameplate consisting of 1/2" letters for equipment designation and 1/4" letters for voltage, source, and feeder information. This includes but is not limited to panelboards, switchboards, switchgear, disconnect switches, transformers, power transfer equipment, generators, motor starters, variable frequency drives, lighting control panels, contactors, cabinets, push button stations, and auxiliary system control panels.

- B. Distribution equipment labels shall indicate the following:
  - 1. Equipment designation.
  - 2. Voltage system.
  - 3. Equipment ampacity.
  - 4. Source equipment designation and location.
  - 5. Feeder size.
  
- C. Transformer labels shall indicate the following:
  - 1. Equipment designation.
  - 2. Primary voltage system and primary feeder ampacity.
  - 3. Source equipment designation and location.
  - 4. Primary feeder size.
  - 5. Secondary voltage system and load equipment designation
  
- D. Equipment disconnect labels shall indicate the following:
  - 1. Equipment designation.
  - 2. Voltage system and feeder ampacity
  - 3. Source equipment designation and location.
  
- E. Locate equipment nameplates at center of top of trim for panelboards, switchboards, switchgear, and centered at side for branch circuit switches.
  
- F. Where equipment is provided with a factory installed disconnecting means or motor controller, install label on factory provided unit.
  
- G. For equipment with multiple power sources, such as transfer switches and control panels, identify each source and its function.
  
- H. Color Legend
  - 1. Normal Power Systems: Black field with white letters
  
- I. Where the premise wiring system has feeders and/or branch circuits supplied from more than one nominal voltage system, provide sign at each switchgear, switchboard, and panelboard displaying color coded identification method for each ungrounded, grounded, and equipment grounding conductor.
  
- J. Service Equipment and Building Feeder, Branch Circuit Disconnects.
  - 1. Provide label for service disconnecting means to permanently identify it as the “SERVICE DISCONNECT”.
  - 2. Where a building or structure has any combination of feeders, branch circuits, or services passing through it or supplying it, provide a permanent sign at each disconnect location identifying all other feeders, branch circuits, or services and the area served by each.

### 3.3 IDENTIFICATION OF CONDUCTORS

- A. Service, Feeder, and Branch-Circuit Conductors: Refer to Section 260519, “Low Voltage Electrical Power Conductors and Cables” for conductor and cable color coding requirements.

- B. Indicate source and circuit number of conductors to be extended in the future.
- C. Auxiliary Systems Alarm, Signal, and Control Wire Identification: At termination points, identify each conductor by its system, designation, and function.

### 3.4 IDENTIFICATION OF RACEWAYS AND BOXES

- A. Identify all junction, outlet, device, and pull boxes with wiring system, voltage, and circuit designations of conductors.
  - 1. In concealed locations above accessible ceilings and in exposed unfinished areas such as data, mechanical, or electrical rooms, provide designations on outside of box covers.
  - 2. For exposed boxes in finished areas, provide designations on inside of box covers.
  - 3. System Legend shall be as follows:
    - a. Power
- B. The inside of all junction and backboxes shall be marked with panel and circuit number in permanent marker.
- C. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate.

### 3.5 IDENTIFICATION OF WIRING DEVICES

- A. All new and existing receptacle cover plates in area of work shall be marked with their panel and circuit number(s) with clear, machine printed adhesive labels with black lettering.

### 3.6 CIRCUIT DIRECTORIES

- A. For Distribution Panelboards, Motor Control Centers, Switchboards, and Switchgear provide nameplates at each switch or circuit breaker to indicate load designation.
- B. Provide clearly legible typewritten directories in each electrical panel indicating the area, item of equipment, etc. controlled by each switch, breaker, fuse, etc. Insert directories into plastic cardholders on the back of the door in each panel. Provide descriptions that identify each circuit as to its clear, evident, and specific purpose or use. The identification shall include an approved degree of detail that allows each circuit to be distinguished from all others. Spaces and Spare positions shall be described accordingly.
  - 1. At a minimum, provide the following panel information for each panel directory:
    - a. Panel name
    - b. Panel bus rating
    - c. Voltage System
    - d. Mains Configuration and Rating
    - e. Short Circuit Current Rating
  - 2. Circuit Designation Examples:
    - a. LIGHTS, ROOM 100
    - b. FLOOR RECEPTACLES, ROOM 200

c. ERV-1 RECEPTACLE, ROOF

- C. Panel Schedules and circuit numbers on Record Drawings shall match.
- D. Provide any existing panel which is affected by the contractor's work with a new typewritten directory.

3.7 SAFETY SIGNS

- A. Install Warning, Caution, and Danger signs in accordance with NFPA 70 and OSHA requirements to ensure safe operation of electrical equipment and the items to which they connect.
- B. Comply with 29 CFR 1910.145 and ANSI Z535.4.
- C. Apply to exterior of door, cover, or other access point.
- D. Labels and signs shall include, but are not limited to, the following legends:
  - 1. Identify system voltage with black letters on an orange background.
  - 2. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 3. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES"
  - 4. Where series combination ratings are allowed: "CAUTION - SERIES COMBINATION SYSTEM RATED \_\_\_\_ AMPERES. IDENTIFIED REPLACEMENT COMPONENTS REQUIRED."

3.8 INSTRUCTION SIGNS

- A. Operating Instruction Signs: Install instruction signs with minimum 3/8-inch letters to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation, power transfer, and load shedding.

END OF SECTION

## SECTION 262726 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

#### 1.2 SUMMARY

- A. This section of the specifications covers all wiring devices and cover plates, standard, weatherproof and dust-tight.
- B. Section Includes:
  - 1. Straight Blade receptacles.
  - 2. GFCI receptacles.
  - 3. Manual Motor Control switches.
  - 4. Wall Plates.

#### 1.3 REFERENCES

- A. Abbreviations
  - 1. CR: Corrosion Resistant
  - 2. EMI: Electromagnetic interference.
  - 3. GFCI: Ground-fault circuit interrupter.
  - 4. WR: Weather Resistant.
- B. Definitions
  - 1. Outlet: A point on the wiring system at which current is taken to supply utilization equipment.
  - 2. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
  - 3. Receptacle. A receptacle is a contact device installed at the outlet for the connection of an attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.
- C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
  - 1. National Electrical Contractors Association (NECA):
    - a. NECA 130, "Standard for Installing and Maintaining Wiring Devices"

2. National Electrical Manufacturers Association (NEMA)
  - a. NEMA WD 1, “General Color Requirements for Wiring Devices”
  - b. NEMA WD 6, “Wiring Devices—Dimensional Specifications”

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide product indicated or equal from one of the following:
  1. Eaton/Arrow Hart
  2. Hubbell
  3. Leviton
  4. Pass & Seymour/Legrand
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

### 2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. RoHS compliant.
- D. Devices for Fixtures, Furnishings, and Equipment:
  1. Receptacles: Match plug configurations.
  2. Cord and Plug Sets: Match equipment requirements.
- E. All terminations shall be side-wired clamping type. “Backstab” terminations or modular connectors are not permitted.
- F. Device Color:
  1. Wiring Devices in unfinished spaces connected to normal power system: Grey unless otherwise indicated or required by NFPA 70 or device listing.
- G. Wall Plate Color:
  1. For plastic covers, match device color unless noted otherwise.
  2. Where normal and essential system devices are ganged under a common wall plate, the plate shall be the color of normal power plates.

2.3 SPECIFICATION GRADE STRAIGHT-BLADE RECEPTACLES

- A. Specification Grade Receptacle, Comply with NEMA WD 6, UL 498, FS W-C-596.

| TYPE      | RATING    | CONFIGURATION | BASIS OF DESIGN |
|-----------|-----------|---------------|-----------------|
| Duplex    | 20A, 125V | NEMA 5-20R    | Hubbell 5362    |
| Single    | 20A, 125V | NEMA 5-20R    | Hubbell 5361    |
| Duplex-WR | 20A, 125V | NEMA 5-20R    | Hubbell 5362WR  |

2.4 SPECIFICATION GRADE GFCI RECEPTACLES

- A. Specification Grade GFCI Receptacles, Comply with UL 498, FS W-C-596, and UL 943 Class A.
- B. Non-feed through type unless otherwise required, Integral self-testing GFCI with "Test" and "Reset" buttons and LED indicator light that is lighted when the unit is tripped. If critical components are damaged and ground fault protection is lost, power to receptacle shall be discontinued.

| TYPE             | RATING    | CONFIGURATION | BASIS OF DESIGN   |
|------------------|-----------|---------------|-------------------|
| Duplex GFCI      | 20A, 125V | NEMA 5-20R    | Hubbell GFRST20   |
| Duplex GFCI - WR | 20A, 125V | NEMA 5-20R    | Hubbell GFTWRST20 |

2.5 MANUAL MOTOR CONTROL SWITCHES

- A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle type for manual control of single or three phase motors up to 3/4 HP where overload protection is not required or is provided separately, marked to indicate whether unit is on or off.
1. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle type with integral overload protection for use with single phase motors up to 1HP; marked to show whether unit is off, on, or tripped.
1. Configuration: Non-reversing unless noted otherwise on drawings.
  2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor and ambient temperature; external reset push button; melting alloy type.
  3. Red pilot light where indicated on drawings.
  4. HOA selector switch with dry contact inputs where indicated on drawings.
- C. Provide with NEMA 1, NEMA 3R or other enclosure suitable for the location and atmosphere.



- D. All manual starters located in finished areas shall be in flush-mounted enclosures.

## 2.6 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Unfinished Spaces: satin-finished, type 304 stainless steel.
  - 3. Material for Rough Service Locations including gymnasiums, kitchens, mechanical rooms, material management, and food service areas: satin-finished, Type 304 stainless steel.
    - a. For kitchen and food service areas, provide foam gasket behind plate to help prevent water infiltration.
- B. Wet-location, Weatherproof, in-use cover plates: extra duty, suitable for use with and decorator style devices, die-cast aluminum lockable cover, self-closing, gasketed, standard box mounting.
  - 1. Vertical mounting - Hubbell WP26E or equal.
  - 2. Horizontal mounting - Hubbell WP26EH or equal.
- C. Cover plates for lighting control devices exposed to severe physical damage: Low profile, flip-up clear polycarbonate cover. STI Stopper or equal.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Provide receptacles and cover plates listed for the installed environment.
- B. Outdoor receptacles and receptacles located in wet locations shall be weather resistant, GFCI type, with weather proof enclosure.
- C. Provide GFCI receptacles where required by the NEC in addition to the locations noted on the drawings.
- D. Provide weather-resistant rating for GFCI receptacles installed in wet locations.
- E. Where GFCI receptacles are located in areas that are not readily accessible, provide GFCI blank face device in readily accessible location approved by Architect.
- F. Provide GFCI receptacles with audible alarm for refrigeration and vending applications.

### 3.2 INSTALLATION

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA 130.
- B. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.

- C. Devices that have been installed before painting shall be masked. No plates or covers shall be installed until all finishing and cleaning has been completed. Replace stained or improperly painted wiring devices and coverplates.
- D. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required. Where GFCI receptacles share a single circuit with other devices, a ground fault on any GFCI receptacle shall not interrupt power to downstream devices.
- E. Coordination for all receptacles: Confirm receptacle configuration of all special purpose receptacles with approved submittals prior to installation and provide devices to match equipment plugs. Contractor shall replace any incompatible receptacle discovered during owner move-in.
- F. Coordination with Other Trades:
  - 1. Adjust locations of outlets to suit arrangement of partitions and furnishings. Locate outlets to avoid blocking by supports, furnishings, and other architectural fixtures.
  - 2. Adjust locations of floor boxes and poke-throughs to coordinate with locations of structural members, concealed piping, and concealed conduit.
  - 3. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  - 4. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 5. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 6. Install wiring devices after all wall preparation, including painting, is complete.
- G. Conductors:
  - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
  - 4. Where re-using existing conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
    - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- H. Device Installation:
  - 1. Replace all devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  - 3. Do not remove surface protection, such as plastic film and smudge covers, until all finish work is complete.
  - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. Use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than #12 AWG are installed on 15- or 20-A circuits, splice #12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
10. Install devices and assemblies level, plumb, and square with building lines. Align devices vertically and horizontally. Securely fasten devices into boxes.

I. Device Orientation:

1. Install switches with "OFF" position down.
2. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left so the neutral blade is at the top.

J. Device Plates:

1. Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
2. All outlets not provided with wiring devices shall be closed with a blank plate matching other plates in the area.
3. Align coverplate mounting screw slots in the same direction, either vertical or horizontal. Do not overtighten coverplate mounting screws. Overtightening can cause the coverplate to warp, dimple, bend, and in the case of plastic faceplates, crack or break.

3.3 IDENTIFICATION:

- A. Comply with Section 260553 "Identification for Electrical Systems."
1. All device boxes shall have circuit number identified within the box.

3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Using a test plug, perform the following tests and inspections for receptacles:
1. Insert and remove test plug to verify that devices are securely mounted.
  2. Verify correct configuration of hot, neutral, and ground pins.
  3. Verify correct operation of ground fault protective devices.
- C. Nonconforming Work:
1. Device will be considered defective if it does not pass tests and inspections.
  2. Remove and replace defective units and retest.
- D. Prepare test and inspection reports.

END OF SECTION

## SECTION 262813 - FUSES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

#### 1.2 SUMMARY

- A. Description: Provide labor, material, equipment, related services, and supervision required for the installation of cartridge fuses where utilized for overcurrent and/or current limitation applications.
- B. Section Includes:
  - 1. Cartridge fuses rated 600V-AC and less for use in control circuits, enclosed switches, panelboards, switchboards, and motor controllers.
  - 2. Spare fuse cabinet.

#### 1.3 REFERENCES

- A. Definitions
  - 1. Fuse: A protective device that opens a circuit during specified overcurrent conditions by means of a current responsive element.
- B. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
  - 1. National Electrical Contractors Association (NECA)
    - a. NECA 420, "Fuse Applications"

#### 1.4 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels indicated in power system study.

## 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace fuses that fail in materials or workmanship within 12 months from date of Substantial Completion.

## 1.6 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Bussmann, Inc.
  - 2. Littelfuse, Inc.
  - 3. Mersen USA.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

### 2.2 GENERAL REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with:
  - 1. NEMA FU 1 – Low Voltage Cartridge Fuses.
  - 2. UL 248 – Standard for Low Voltage Fuses.
  - 3. UL 512 – Fuseholders.

### 2.3 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
  - 1. Type RK-1: 250 or 600-V, zero- to 600-A rating, 200 kAIC minimum, fast acting or time delay.
  - 2. Type RK-5: 250 or 600-V, zero- to 600-A rating, 200 kAIC minimum, fast acting or time delay.
  - 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC minimum, fast acting or time delay.

4. Type L: 600-V, 601- to 6000-A rating, 200 kAIC minimum, time delay option.
- B. Voltage: Rating suitable for circuit phase-to-phase voltage.
- C. Provide dual element fuses with separate overload and short circuit elements.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 FUSE APPLICATIONS

- A. Motor Circuits – Class RK1 or Class L, time delay as indicated above.
  1. Motor with 1.15 service factor: Size at 125% of motor FLA. For high inrush current applications size 150% to 200% of motor FLA.
  2. Motor with 1.0 service factor: Size at 115% of motor FLA.
- B. Control Circuits: Class CC, time delay. Bussmann Low-Peak Fuses LP-CC or equal. Fuses shall hold 200% of rated current for a minimum of 12 seconds.
- C. Adjust fuse type and selection as required to ensure available fault current at equipment controllers indicated in power systems study does not exceed labeled SCCR values.

#### 3.3 INSTALLATION

- A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energizing at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energizing of the circuit in which it is applied.

- B. No fuses shall be installed in the equipment until the installation is complete, including tests and inspections required prior to being energized. All fuses shall be of the same manufacturer to ensure retention of selective coordination, as designed.
- C. Provide a complete set of fuses for all fusible devices. Arrange fuses so rating information is readable without removing fuse.
- D. Upon completion of the building, the Contractor shall provide the Owner with spare fuses in Spare-Fuse Cabinet.

### 3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems".
  - 1. Indicate fuse rating and type on the outside door of each fused switch.

END OF SECTION

## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

#### 1.2 SUMMARY

- A. Description: Section includes requirements for the provision of individually enclosed switches and circuit breakers including manufacturing, fabrication, configuration and installation as required for the complete performance of the Work, as shown on the drawings and specifications
- B. Section includes:
  - 1. Fusible and Non-Fusible Switches.
  - 2. Enclosed Circuit Breakers.
  - 3. Enclosures.

#### 1.3 REFERENCES

- A. Abbreviations
  - 1. HD: Heavy Duty
  - 2. MCCB: Molded Case Circuit Breaker
  - 3. NC: Normally Closed
  - 4. NO: Normally Open
  - 5. SCCR: Short Circuit Current Rating
- B. Definitions
  - 1. Disconnect: A switch, device, group of devices, or other means used to disconnect conductors of a circuit from their source of supply.
  - 2. Switch (switching device): A device, manually operated, unless otherwise designated, for opening and closing or for changing the connection of a circuit. Also referred to as safety switches or disconnect switches.

#### 1.4 COORDINATION

- A. Product Selection for Restricted Space: Drawings indicate space available for enclosed switches including clearances between enclosed switches and adjacent surfaces and other items. Furnish and install equipment to comply with NEC clearances.



## 1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace devices that fail in materials or workmanship within 12 months from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB/General Electric.
  - 2. Eaton Electrical Inc.
  - 3. Siemens.
  - 4. Square D
- B. Source Limitations: Obtain enclosed switches, overcurrent protection devices, and all other electrical distribution equipment through one source from a single manufacturer unless approved otherwise.

### 2.2 GENERAL REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Service-Rated Switches and Circuit Breakers: Labeled for use as service equipment.
- D. Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Switch and overcurrent protective device short circuit ratings shall be at least 110% of the actual available fault current.

### 2.3 FUSIBLE AND NON-FUSIBLE SWITCHES

- A. Type HD, Heavy Duty, Single Throw, 250-VAC or 600-VAC, 1200 A and Smaller unless noted otherwise.
- B. Quick-make, quick-break operating handle and switch mechanism integral to box.
- C. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses where indicated.

- D. Externally operable dual interlocked handle to prevent opening front cover with switch in ON position, or closing switch when door is open. Visible load interrupter knife switch blades in the off position with door open.
- E. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- F. All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.
- G. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Lugs: UL Listed, mechanical type, front removeable, and suitable for number, size, and conductor material at 75 deg C.
  - 4. Auxiliary Contact Kit: NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating as required for application.
  - 5. Electrical Interlock Kit: Pivot arm operated from the switch mechanism, breaking a control circuit before the main switch blades break.
- H. For receptacle switches provide interlocking linkage between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

#### 2.4 ENCLOSED MOLDED-CASE CIRCUIT BREAKERS

- A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. MCCBs shall be equipped with a device for locking in the open position.
- E. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

- F. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - 1. Long-time, Short-time, and Instantaneous trip unless noted otherwise on drawings.
- G. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single-, two-pole, and three-pole configurations with Class A ground-fault protection (6-mA trip).
- I. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- J. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Lugs: UL Listed, mechanical type, suitable for number, size, trip ratings, and conductor material at 75 deg C.
  - 3. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact. Coordinate coil voltage and provide control circuits as required for application.

## 2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor and Wet Locations: NEMA 250, Type 3R.
  - 3. Kitchen and Wash-Down Areas: NEMA 250, Type 3R, stainless steel.
- B. Enclosure Finish: The enclosure shall be finished with the standard manufacturer gray finish.
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Securely fasten each switch and circuit breaker to the supporting structure or wall, utilizing a minimum of four (4) 1/4-inch bolts. Do not mount in an inaccessible location or where the passageway to the switch may become obstructed.
- D. After equipment has been installed, inspected, and is ready to be energized, install fuses in fusible devices in accordance with equipment nameplates and Section 262816, "Fuses".
- E. Comply with NFPA 70 and NECA 1.
- F. Provide electrical interlock kit and low voltage wiring where utilized on the line side of VFD controller to shut down VFD prior to disconnection of power. Coordinate control wire termination with Division 25.
- G. Provide fusible switches with current limiting fuses or current limiting circuit breaker for equipment disconnecting means where equipment short circuit current rating is insufficient for available fault current.

### 3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, use a calibrated torque tool to achieve that indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

### 3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553, "Identification for Electrical Systems"
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with nameplate.

### 3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Visual and Mechanical Inspection:

- a. Examine equipment nameplate data and confirm proper identification.
  - b. Verify and record fuses sizes and types are in accordance with nameplates and power systems study.
  - c. Inspect the physical, electrical, and mechanical condition of the equipment and all components in accordance with the manufacturers' instructions.
  - d. Inspect anchorage, alignment, and grounding.
  - e. Inspect bolted electrical connections and terminations for high resistance by verifying tightness with calibrated torque-wrench method in accordance with manufacturer's published data.
  - f. Exercise all active components to ensure proper mechanical operation.
  - g. Check all interlocking systems for correct operation.
2. Test all auxiliary devices/system interfaces and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- B. Switches and Circuit Breakers will be considered defective if they do not pass tests and inspections.
- C. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Prepare test and inspection reports, including a certified report that identifies switches and circuit breakers included and that describes results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

## SECTION 262900 - MOTOR CONTROLLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260010 "General Requirements for Electrical Systems" apply to this Section.

#### 1.2 SUMMARY:

- A. Extent of motor starter work is indicated by drawings and schedules.
- B. Section includes:
  - 1. Combination full voltage, non-reversing Motor Controllers.
  - 2. Combination Soft Start Motor Controllers
- C. Related Requirements:
  - 1. Refer to Section 260500 "Common Work Results for Electrical Systems" for additional requirements related to motors connections.
  - 2. Refer to Section 262726 "Wiring Devices" for information on manual motor controllers.

#### 1.3 REFERENCES

- A. Abbreviations
  - 1. FVNR: Full Voltage Non Reversing
  - 2. MCP: Motor Circuit Protector
  - 3. OCPD: Overcurrent protective device
  - 4. SCCR: Short Circuit Current Rating
  - 5. SCPD: Short-circuit protective device
  - 6. SCR: Silicon Controlled Rectifier
- B. Definitions
  - 1. Soft Starter: Solid state reduced voltage non-reversing motor controller

#### 1.4 SUBMITTALS:

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of product.

1. Include wiring diagrams for signal and control wiring. Clearly identify manufacturer-installed and field installed wiring.
2. Include features and factory settings of individual protective devices and auxiliary components.

C. Closeout Submittal:

1. Operation and Maintenance Data: For motor controllers to include in operation and maintenance manuals.
2. In addition to items specified in Division 01 and Section 260010 "General Requirements for Electrical Systems", include the following:
  - a. Routine maintenance requirements for magnetic controllers and installed components.
  - b. Manufacturer's written instructions for testing and adjusting circuit breaker and motor circuit protector trip settings.
  - c. Manufacturer's written instructions for setting field-adjustable overload relays.
  - d. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

## 1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace enclosures, starters, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within 12 months from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS:

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
- B. UL Compliance and Labeling: Fabricate and label motor controllers to comply with UL 508.
- C. NEC Compliance: Comply with NEC as applicable to wiring methods, construction and installation of motor starters.
- D. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to motor controllers/starters and enclosures.

### 2.2 MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide products from one of the following:

1. ABB/General Electric
2. Allen Bradley Co.
3. Eaton
4. Siemens.
5. Square D. Co.

## 2.3 MANUAL MOTOR CONTROLLERS

- A. Refer to Section 262726 “Wiring Devices” for manual motor controller requirements.

## 2.4 COMBINATION FULL VOLTAGE MOTOR CONTROLLER

- A. Description: Factory-assembled, combination full-voltage, non-reversing magnetic motor controller consisting of the controller, indicated disconnecting means, SCPD, OCPD, pushbuttons, selector switch(es), and indicator lights in a single enclosure.
- B. All combination starter/disconnect switches shall have low-voltage protection, solid state overloads, start / stop pushbuttons, Hand-Off-Auto selector switch and Red and Green pilot lights.
- C. All combination starter/disconnect switches shall be Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Combination motor starters shall be rated in accordance with NEMA sizes and horsepower ratings. No starter shall be listed as a fractional size. Contactor contacts shall be silver alloy, double break, and shall allow for inspection on NEMA Sizes 00 through 4 without the use of tools. Size 5 and larger shall allow for inspection utilizing standard tools. They shall be replaceable without removing the line, load, or control wiring from the starter, and replaceable without removing the starter from the enclosure.
- E. Contactor coils shall be the encapsulated type, and shall be replaceable on NEMA Sizes 00 through 4 without the use of tools. Size 5 and larger shall be replaceable with standard tools. They shall be replaceable without removing the line, load, or control wiring from the starter, and replaceable without removing the starter from the enclosure.
- F. Overload protection shall be provided by solid state electronic overload relay. Single-phase starters shall provide one- or two-leg overload protection; three-phase starters shall provide three-leg overload protection. Overload protection shall be class 10/20 selectable, have visible trip indicator, and manual or remote reset function.
- G. Starter shall include phase failure relay with under-voltage protection.
- H. Starter shall have integral controls transformer with primary and secondary fusing.
- I. Starter to have two normally closed and two normally open auxiliary contacts.
- J. Combination starter shall be suitable for straight through wiring.



- K. Fusible Disconnecting Means: Heavy Duty, quick-make, quick-break, load break rated, such that during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing and opening action of the contacts has started. The handle and mechanism shall be an integral part of the box (not cover) with facilities for pad locking in the open or closed position with up to three padlocks. Switch doors shall be interlocked with switch handle so that the door can only be opened when the switch is in the "OFF" (open) position.
- L. All safety switches shall have a factory installed neutral lug, when a neutral is necessary.
- M. All current carrying parts shall be plated by an electrolytic process to resist corrosion and to promote cooling.
- N. Provide the following Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.5 COMBINATION SOFT START MOTOR CONTROLLER

- A. Description: Factory Assembled, Solid state, reduced voltage, non-reversing motor controller consisting of controller, disconnecting means, protection devices, microprocessor with digital keypad in a single enclosure.
- B. Enclosure shall include a door mounted digital keypad for adjusting the soft starter parameters and viewing process values and viewing the motor and soft starter status without opening the enclosure door. Provisions shall be available for padlocking the enclosure door.
- C. The enclosed product shall be provided with molded case disconnect switch and in-line fuse block for Class J power fuses from 10 to 600A or Class L power fuses from 601 to 1600A for Type 1 short circuit protection.
- D. The motor must be automatically protected from solid state component failure by an isolation contactor that opens when the motor is stopped or when the controller detects a fault condition including a shorted SCR.
- E. The soft starter shall utilize an SCR bridge consisting of at least two SCRs per phase to control the starting and stopping of industry standard motors.
- F. The soft start shall provide torque control for linear acceleration independent of motor load or application type without external feedback. The gating of the SCRs will be controlled in such a manner to ensure stable and linear acceleration ramp.
- G. The soft starter shall be controlled by a microprocessor that continuously monitors the current and controls the phasing of the SCRs. Analog control algorithms shall not be allowed.

- H. A shorting contactor shall be standard on soft starters in all enclosure configurations. Protective features and deceleration control options integral to the soft starter shall be available even when the shorting contactor is engaged.
- I. The SCRs shall have a minimum P.I.V. rating of 1800 Vac. Lower rated SCRs with MOV protection are not acceptable.
- J. All programming/configuration devices, display units, and field control wiring terminals shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments is prohibited.
- K. Digital indication shall provide, as a minimum, the following conditions:
  - 1. Soft starter status - ready, starting/stopping, run.
  - 2. Motor status - current, torque, thermal state, power factor, operating time, power in kW.
  - 3. Fault status - Motor thermal overload, soft starter thermal fault, loss of line or motor phase, line frequency fault, low line voltage fault, locked rotor fault, motor underload, maximum start time exceeded, external fault, serial communication fault, line phase reversal fault, motor overcurrent fault.
- L. The soft starter must be preset to the following for adjustment-free operation in most applications:
  - 1. Linear (torque-controlled) acceleration ramp of 15 seconds.
  - 2. Current limitation to 400% of the motor full load current rating.
  - 3. Class 10 overload protection.
  - 4. Motor current preset per NEC / NFPA 70 table 430.150 for standard hp motors.
- M. A digital keypad shall be utilized to configure operating and controller parameters such as FLA, acceleration ramp, torque, braking type, thermal overload Class, reset functions, etc.
- N. Provide output relays to provide the following status indications:
  - 1. One Form A (N.O.) minimum for indication of fault.
  - 2. One Form A (N.O.) for indication that acceleration ramp is complete and current is below 130% motor FLA (end of start).
  - 3. One Form A (N.O.) assignable to one of the following functions: motor thermal alarm, motor current level alarm, and motor underload alarm.
- O. A microprocessor-based thermal protection system shall be included which continuously calculates the temperature-rise of the motor and soft starter and provides:
  - 1. A motor overload pre-alarm that indicates by relay contact or logic output that the motor windings have exceeded 130% of its rated temperature rise. This function shall be for alarm only.
  - 2. A motor overload fault will stop the motor if the windings have exceeded 140% of temperature-rise.
  - 3. An electronic circuit with a time-constant adjustable to the motor's thermal cooling time-constant ensuring the memorization of the thermal state even if power is removed from the soft starter.
  - 4. The soft starter shall provide line and motor phase loss, phase reversal, underload, stall, and jam protection.

5. The integral protective features shall be active even when the shorting contactor is used to bypass the SCRs during steady state operation.
  6. The soft starter control circuit shall be fed from the line supply and be completely independent of the power circuit and separate from the control logic.
- P. The peripheral soft starter control circuitry shall be operated at 120 Vac 60 Hz from a control power transformer included within the enclosure.
- Q. Operator devices shall be door mounted and shall be:
1. Red STOP and black START push buttons.
  2. Three position H-O-A switch which provides for manual (HAND) start or remote signal (AUTO) start from user-supplied relay contacts.
  3. Three position FWD-OFF-REV switch provides forward, off and reverse selector switch mounted on the door (available with reversing starter only).
  4. Red RUN pilot light illuminated whenever the soft starter is provided a run command and no fault condition is present.
  5. Green OFF pilot light illuminated whenever the soft starter is supplied with control power and no run command is present.
  6. All operator devices shall be remote-mounted using supplied 120 Vac control logic. Clearly labeled terminals shall be provided for field installation.
- R. Provide a shorting contactor that shall close, shorting the SCRs after the acceleration ramp is complete and motor current is below 130% of motor FLA, and open on a stop command to allow a deceleration ramp. Overload protection integral to the soft starter shall continue to protect the motor when shorting is engaged. A microprocessor shall control the operation of the shorting contactor via an output relay.
- S. Provide full voltage bypass starter with overload protection to provide motor operation in the event of soft starter failure. Provide "NORM/BYPASS" selector switch on enclosure door.

## PART 3 - EXECUTION

### 3.1 MOTOR CONTROLLER APPLICATION

- A. FVNR and Soft Starter type motor controllers shall be combination type starter and disconnect switch unless noted otherwise on plans.
- B. Starters smaller than 10HP shall be full voltage non-reversing type (FVNR). Starters 10HP and larger shall be soft starters.
- C. The starter shall be designed to operate in the environment in which installed including ambient temperature, humidity, and elevation.
- D. Enclosure:
  1. Type of each starter to comply with environmental conditions at installed location:
    - a. Indoor, Dry and Clean Locations: NEMA 250, Type 1
    - b. Outdoor Locations: NEMA 250, Type 3R.

- c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
2. Provide provisions for padlocking the enclosure door.

### 3.2 EXAMINATION

- A. Examine elements and surfaces to receive motor starters for compliance with installation tolerances, relationship to motors, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 INSTALLATION OF MOTOR CONTROLLERS:

- A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA standards, and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Securely fasten each switch, circuit breaker and combination starter to the supporting structure or wall, utilizing a minimum of four (4) 1/4 inch bolts.
- D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NEC. Do not mount in an inaccessible location or where the passageway to the switch may become obstructed.
- E. Install fuses in fusible devices in accordance with Section 262813, "Fuses".
- F. Select and set overloads on the basis of full-load current rating as shown on motor nameplate.
- G. Verify that overcurrent and overload protection devices are properly matched to actual motor nameplate data and service class.
- H. Provide conductor reducers, taps and splices, as required, for proper termination of all branch circuits and feeders at disconnect switches, panelboards, motor starters, VFDs, etc. This shall include where conductors have been oversized to accommodate voltage drop, motor circuit conductor protection, and all instances where conductors are unable to terminate at factory lugs.
- I. Final 18 inch of power wiring to motor shall be in liquid tight flexible conduit.

### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, use a calibrated torque tool to achieve that indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

### 3.5 IDENTIFICATION

- A. Comply with requirements in Section 260553, "Identification for Electrical Systems"
  - 1. Identify field-installed conductors, interconnecting wiring, and components.
  - 2. Provide Warning Signs.
  - 3. Label each enclosure with nameplate.

### 3.6 FIELD QUALITY CONTROL:

- A. Perform Test and Inspections:
  - 1. Visual and Mechanical Inspection:
    - a. Compare equipment nameplate data with drawings and specifications.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, and grounding.
    - d. Verify the unit is clean.
    - e. Inspect contactors:
      - 1) Verify mechanical operation.
      - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
    - f. Motor Protection:
      - 1) Verify overload element rating is correct for its application.
      - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
    - g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench or low resistance ohmmeter. Bolt-torque levels and/or bolted connection resistance values shall be according to manufacturer's published data.
    - h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
  - 2. Electrical Tests:
    - a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data.
    - b. Test motor protection devices according to manufacturer's published data.
    - c. Verify voltages at the controller locations are within plus or minus 10 percent of the motor nameplate rated voltages. If outside the range for any motor, notify the design team before starting the motor.
    - d. Perform operational tests by initiating control devices.
    - e. Test all auxiliary devices/system interfaces and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Motor controller will be considered defective if it does not pass tests and inspections.
- C. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance, otherwise replace with new units and retest.
- D. Prepare test and inspection reports, including a certified report that identifies motor controllers included and that describes results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION.

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