

**TECHNICAL SPECIFICATIONS  
FOR  
NORTH CAMPUS NA BUILDING  
CHILLER REPLACEMENT AND  
RE-WORK MECHANICAL ROOM CHILLED  
WATER PIPING  
CAPE FEAR COMMUNITY COLLEGE  
NORTH CAMPUS**



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Castle Hayne, North Carolina**

**SEPTEMBER 7, 2022**



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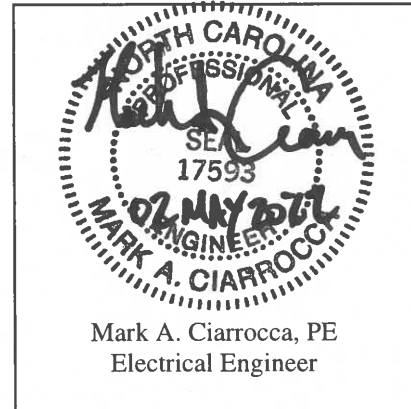
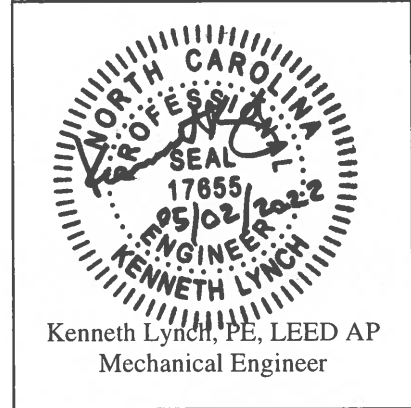
**TECHNICAL SPECIFICATIONS**

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SECTION 230500 – MECHANICAL

230501 GENERAL

- A. Drawings and general provisions of the Contract, including General and Supplementary General Conditions and Division 1 Specification Sections, apply to this Section.
- B. The Mechanical Contractor shall be the Prime Contractor and shall coordinate with his subcontractors to see that all trades are on schedule.
- C. The Mechanical Contractor shall install all work in accordance with the requirements of the latest edition of the North Carolina State Building Code. Codes to be a part of these specifications: North Carolina State Building Code, National Fire Protection Association Codes Section 70, 90A, 91 and other applicable sections.
- D. Permits and Inspection Fees: The Mechanical Contractor shall secure all necessary required permits and inspections for this work. Charges for permits shall be included in the Contractor's bid. Inspection by local authorities will be required.
- E. The drawings accompanying these specifications indicate diagrammatically the general location of the piping, and equipment and do not show all offsets, supports, fittings, bolts, connections, etc., required for a complete system. While the drawings are to be followed as closely as possible, if it is found necessary to change the location of same to accommodate the conditions at the building, such changes shall be made without additional cost to the Owner, and as directed by the Engineer. Any detail which is omitted, and which is necessary for the proper operation of any system included under the contract, shall be supplied and installed by the Mechanical Contractor without extra cost to the Owner. All equipment shall be installed in such a manner as to allow proper maintenance access.
- F. Equipment and Materials shall be delivered to the site and stored in original containers, suitably sheltered from the elements, but readily accessible for inspection by the Engineer until installed. All items subject to moisture damage shall be stored in dry spaces.
- G. Conditions shall be checked at the building before placing orders for apparatus and such apparatus shall be of such dimensions as to fit the spaces allotted. The Mechanical Contractor shall not scale mechanical plans, but rather take field measurements.
- H. By signing the Contractor's Proposal, it is understood and agreed that the Mechanical Contractor has, by careful examination, satisfied himself with the quantity, quality, and location of all excavation materials to be encountered in his contract. No additional payment will be approved for adjustments made for underground piping not being located where shown on the drawings or any other existing conditions encountered.
- I. All debris resulting from mechanical work shall be removed from the premises daily or as directed by the Engineer. Trash and rubbish shall not be allowed to accumulate either within or outside the building. Materials and debris, which in the opinion of the Engineer cannot practicably be removed from the site the same day, may be temporarily stacked or stored in a designated location on the site as directed by the Engineer.

- J. Guards shall be provided for all moving equipment, motor couplings, belt drives and similar exposed reciprocating or rotating components.
- K. All mechanical equipment shall be labeled in accordance with Section 301 of the North Carolina Mechanical Code and as required by the Authority having jurisdiction. Labeling shall be a permanent factory-applied nameplate affixed to the equipment on which shall appear in legible lettering, the manufacturer's name or trademark, the model, serial number, and the seal or mark of the testing agency.

#### 230502 SCOPE

- A. The Mechanical Contractor shall provide labor and materials required for a complete system ready for operation as shown on the drawings and hereinafter specified. This includes all equipment, piping, controls, necessary plumbing, and all other services whether they are specifically mentioned herein or not. The entire installation shall be installed in a first-class, neat, professional manner to the satisfaction of the Engineer and shall conform to all applicable codes and laws.

#### 230503 DEMOLITION

- A. General Requirements: The work includes the demolition or removal of all construction indicated, specified, or necessary to accomplish the work under this contract. All items not to be reused shall become the property of the Heating and Air Conditioning Contractor. The drawings define the scope of work, but it is not intended that all items of demolition work be specifically indicated. After carefully reviewing the drawings and specifications to determine intent, and prior to bidding, the Heating and Air Conditioning Contractor shall visit the site and determine the extent of demolition work required to properly complete the work under his contract.
- B. Protection of Materials and Work: Before beginning any cutting or demolition work, the Heating and Air Conditioning Contractor shall carefully survey the existing work and examine the drawings and specifications to determine the extent of work required. The Heating and Air Conditioning Contractor shall take all necessary precautions to insure against damage to existing work to remain in place, to be reused, or to remain the property of the Owner, and any damage to such work shall be repaired or replaced at no additional cost to the Owner.
- C. The Contractor shall notify the Owner immediately in the event that any asbestos is encountered during demolition.
- D. Refrigerant in Demolitioned Equipment: Recover all refrigerant in approved refrigerant containers and in compliance with section 608 of the EPA Clean Air Act. Removal must be conducted under supervision of an EPA certified technician.

#### 230504 SHOP DRAWINGS AND SUBMITTAL DATA

- A. The Mechanical Contractor shall submit within 10 days after award of the contract a list of materials and the manufacturer to be used on this project. He shall submit within thirty days after award of the contract at least five copies of submittal data in written form for the Engineer's use in approving materials and equipment. One copy will be returned. If the Mechanical Contractor desires the return of more than one copy, additional copies shall be provided to the Engineer at

the time of the original submission. It is requested that all submittal data be sent to the Engineer at one time. Unless special consideration is given, none of the submittal data will be checked until it has all been received by the Engineer. Where called for, the Mechanical Contractor shall submit five sets of shop drawings showing the detailed arrangement or connections that are shown schematically on the drawings. Data certified for the specified project and indicated manufacturer, type, or size, capacity, etc., shall be submitted for the following equipment items:

1. Chillers
2. Pumps
3. Air & Dirt Separators
4. Valves
5. Controls with Complete Diagram
6. Heat Trace Cable System
7. Piping
8. Insulation
9. Test and Balance

230505 APPROVED EQUAL EQUIPMENT, ETC.

- A. Manufacturers listed are to establish a standard of quality and not intended to limit the selection to these manufacturers. All materials and equipment which are essential and have not been specified or shown shall be new and of the highest grade and quality, free from defect or other imperfections. It should be understood that where the word "provide" is used, it is intended that the Mechanical Contractor shall purchase and install all materials required. Approval of equipment will not relieve the Contractor of compliance with the specifications even if such approval is made in writing, unless the attention of the Engineer is called to the non-complying features by letter accompanying the submittal data. Approval of submittal data by the Engineer shall not be construed as a complete check of approval of detailed dimensions, weights, gauges, and similar details with the proposed articles. The conformance with the necessary coordination between the various other contractors and suppliers shall be solely the responsibility of the Mechanical Contractor.

230506 CHILLERS

- A. Mechanical Contractor shall furnish and install an air cooled chillers as shown and scheduled on the drawings and hereinafter specified. Unit shall produce the specified tonnages per the scheduled data in accordance with ARI Standard 550/590-2003. Unit shall bear the ARI certification label as applicable and shall conform to ARI Standard 550/593-2003 and UL 1995.
- B. Chillers shall be factory pressure tested, evacuated and fully charged with HFC-134a or R-410a refrigerant and oil. Functional test to verify correct operation by cycling condenser fans, closing compressor contacts and reading data points from temperature and pressure sensors shall be performed at the factory.
- C. Provide complete parts and labor warranty for the entire chillers for one year. Refrigeration compressors shall have five year parts warranty. Labor, freight, refrigerant, and any other required parts during compressor warranty years two through five shall be provided or paid for by the Owner.

D. Chillers Acoustical Requirements:

1. Provide sound attenuation systems of factory provided heavy duty oil and water resistant flexible type removable sound cover wraps for compressors, piping, etc. and low noise condenser fans.

E. Approved manufacturers:

1. Trane
2. Carrier
3. JCI/York

F. Provide complete factory assembled, single-piece chassis, air cooled type chillers with rotary screw compressors as shown and scheduled on the drawings. (Scroll compressor with R-410a refrigerant is acceptable). Contained within the package shall be all factory wiring, piping, controls, refrigerant charge (screw HFC-134a or scroll R-410a), and all customary auxiliaries deemed necessary by manufacturer for safe and automatic operation of the chillers.

G. Each chillers shall have a minimum of two compressors for two independent refrigerant circuits per chillers to provide multiple step capacity control. Compressors shall be direct drive, 1750 rpm, semi-hermetic rotary screw compressor with double mesh suction inlet screen, electric actuated cylinder unloaders (if unit has only two compressors), oil management system, reversible oil pump, crankcase heater, electronic expansion valve with site glass, oil level sight glass, oil charging valve, replaceable core filter drier, suction and discharge service valves, and rubber-in-shear isolators. Motors shall have one solid-state sensor imbedded in each motor winding to protect against excessive winding temperature.

H. Evaporator shall be tube-in-shell design with seamless copper tubes roller expanded into tube sheets or brazed plate heat exchanger. Chillers assembly shall be designed, tested, and stamped in accordance with ASME code for a refrigerant side working pressure of 225 PSIG and waterside working pressure of 150 PSIG. Evaporator shall be insulated and include a drain connection and connections for chilled water inlet and outlet. Water strainer with blowdown valve shall be factory provided for each chillers and installed in accordance with chillers's installation instructions. Factory provided flow switch for each chillers shall be IFM flow monitor type and installed the correct number of pipe diameters from any elbow and in the correct orientation. Heater tapes with thermostatic control shall be provided on the shell and all internal unit water piping to protect components from freeze-up down to -20°F ambient temperatures.

I. Condenser shall be coils consisting of aluminum fins mechanically bonded to seamless copper tubes complete with a subcooler circuit with liquid accumulator or micro channel condenser coils. Condenser and subcooler coils shall be tested at 700 PSIG air pressure. Vertical discharge low noise condenser fans shall be statically and dynamically balanced direct driven by three-phase motors with permanently lubricated ball bearings and three-phase thermal overload protection. Unit shall be capable of starting and operating at outdoor ambient temperatures from 0F to 125F.

J. Chillers shall be constructed of hot-dipped galvanized steel frame, panels, and access doors. Protective grilles shall be mounted over condenser fans, condenser coils, and compressor access areas for protection. Component surfaces shall be finished with a powder-coated paint. The coating or paint system shall withstand a 1000-consecutive-hour salt spray application in accordance with standard ASTM B117.



- K. Entire chillers including all coils shall have field applied protective surface treatment. Surface treatment shall be Adsil MicroGuard applied by Energy Guard (phone: 919-777-0965) or approved equal per the following:
1. Surface Treatment shall be ambient air temperature cured, inorganic film structures.
  2. Surface Treatment shall not act as an insulating barrier to the substrate, which would inhibit or degrade heat transfer coefficients or increase energy consumption of the condenser.
  3. Surface Treatment shall adhere to substrates by direct atom-to-atom covalent bonding, as well as London Force method.
  4. Surface Treatment shall produce a dry film thickness no greater than 8 microns.
  5. Surface Treatment shall have passed ASTM G-21, with a zero (0) microbial spore growth development rating. The standard ASTM G-21 test must have been conducted by an accredited, third party, independent laboratory.
  6. Surface Treatment shall meet or exceed 6,000 hours of corrosion protection using ASTM B117 testing protocols.
- L. Enclosures shall be weather-tight, unit-mounted, NEMA 250, hinged and lockable. Unit mounted starters shall be in the enclosure. Starter shall be across-the-line configuration, factory-mounted and fully pre-wired to the compressor motor(s) and control panel. Unit shall have a single point power connection. Control power transformer shall be factory-installed and factory-wired to provide unit control power. Control panel shall be dead front construction for enhanced service technician safety. Power line connection type shall be standard with a terminal block. Unit wiring shall run in liquid-tight conduit.
- M. Controls, Safeties, and Diagnostics:
1. The microprocessor-based unit controller shall be factory-installed and factory-tested. Digital Communications to BAS system shall be as necessary to be fully connected to and integrated with the building's existing Schneider Electric Andover DDC system, including graphics.
  2. The unit display shall provide the following data:
    - a. Water and air temperatures
    - b. Refrigerant levels and temperatures
    - c. Flow switch status
    - d. Compressor starts and run times
  3. Unit controller shall provide chilled water temperature reset based on return water temperature.
  4. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chillers by the chillers manufacturer. Controls shall include the following readouts and diagnostics:
    - a. Low evaporator refrigerant temperature and/or pressure
    - b. High condenser refrigerant pressure
    - c. Motor current overload
    - d. High compressor discharge temperature
    - e. Electronic distribution faults: phase loss, phase imbalance, or phase reversal
  5. Phase loss and under voltage relays shall be part of a solid-state sensing circuit with adjustable under voltage setting and isolated output contacts for hard wired connections.

6. Surge suppressors in solid-state power circuits shall provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
7. Unit shall be shipped with factory control and power wiring installed.
8. On chillers, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer and a single 115 volt 60 Hz single phase connection for evaporator freeze protection heaters.
9. The unit controller shall utilize the following components to automatically take action to prevent unit shutdown due to abnormal operating conditions which will perform as follows:
  - a. High pressure switch that is set 20 PSIG lower to automatically shut off a compressor to help prevent a high pressure condenser control trip. One switch is required for each compressor and indicating light shall also be provided.
  - b. Motor surge protector that is set at 95% of compressor RLA that will automatically shut off a compressor to help prevent an over current trip. One protector is required for each compressor and indicating light shall also be provided.
  - c. Low pressure switch that is set at 5 PSIG above the factory low pressure switch that will automatically shut off a compressor to help prevent a low evaporator temperature trip. One switch is required for each compressor and indicating light shall also be provided.
10. Provide the following safety controls with indicating lights or diagnostic readouts:
  - a. Low chilled water temperature protection.
  - b. High refrigerant pressure.
  - c. Low oil flow protection.
  - d. Loss of chilled water flow.
  - e. Contact for remote emergency shutdown.
  - f. Motor current overload.
  - g. Phase reversal/unbalance/single phasing.
  - h. Over/under voltage.
  - i. Failure of water temperature sensor used by controller.
  - j. Compressor status (on or off).
11. Provide the following operating controls:
  - a. Chilled water pump output relay that closes when the chillers is given a signal to start.
  - b. High ambient pressure controller that shuts off a compressor to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.
  - c. Compressor current sensing limit that shuts off a compressor to help prevent current overload nuisance trips.
  - d. Auto lead-lag functions that constantly even out run hours and compressor starts automatically. If contractor cannot provide this function, then cycle counter and hour meter shall be provided for each compressor so owner can be instructed by the contractor on how to manually change lead-lag on compressors and even out compressor starts and running hours.
  - e. Low ambient lockout control with adjustable setpoint.
12. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:

- a. Leaving chilled water setpoint adjustment from LCD input
  - b. Entering and leaving chilled water temperature output
  - c. Percent RLA output for each compressor
  - d. Pressure output of condenser for circuits one and two
  - e. Pressure output of evaporator for circuits one and two
  - f. Ambient temperature output
  - g. Voltage output
  - h. Current limit setpoint adjustment from LCD input.
  - i. Remote leaving water temperature setpoint.
  - j. Alarm indicating light and relay.
- N. Install chillers in accordance with manufacturer's instructions. Chillers shall be installed level and on manufacturer furnished elastomeric or neoprene isolators, not pads.
- O. Chillers startup and Owner training shall be performed by Factory trained and authorized servicing technicians confirming equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under warranty. Provide startup reports to Architect/Engineer.

#### 230507 PUMPS

- A. Base mount end suction pumps shall be centrifugal type with 125# flanged connections and rated for 175-psig and 250°F. Pump and motor shall be mounted on grout-able structural steel channel base with factory-standard integral drain pan with 3/4" drain connection. Casing connections shall be drilled and tapped for gauges and seal cavity shall include factory-installed external seal flush line. Pump volute shall be foot mounted back-pullout design (overhung casing designs are not allowed). Pump shall be bronze-fitted with carbon steel shaft, ceramic/EPT mechanical seal, and utilized a dry shaft design with field replaceable slip-on bronze shaft sleeve. Bearing frame shall incorporate maintenance free permanently lubricated and sealed bearings with L10 life of 60,000 hours. Coupler shall be Woods Dura-Flex with zinc shear bolts and covered by OSHA-approved coupling guard. Motors shall be rated NEMA Premium Efficient and comply with EISA 2007 and shall have efficiency rating stamped on motor nameplate. On motors equal to or greater than 7-1/2 hp served by variable speed drives, provide shaft grounding rings.

Install pumps per manufacturer's recommendations. All bases shall be grouted. Pipe drain pans to drain. Properly support adjacent piping to ensure no external forces are exerted on the pump casing. Perform preliminary pump and motor shaft alignment upon initial receipt of unit, after pump is piped and grouted, and after system is filled and flushed. Pumps shall NOT be run dry to check rotation. Final alignment shall utilize a laser alignment tool and shall be performed after system reaches normal operating temperature. Provide verified laser alignment results to the owner, demonstrating 0.003" parallel and 3° angular alignments.

End suction pumps shall be provided with a multi-function inlet suction diffuser. Suction diffuser body and cover plate shall be ductile iron, rated for 175-psig. The suction guide shall include full length stainless steel straightening vanes, permanent stainless steel strainer, disposable 16 mesh bronze start-up strainer, blow down ports, and metering ports. Startup strainers shall be attached to adjacent shut-off valve with copper wire after removal. Install foot supports under each suction diffuser to alleviate any external stresses on the pump.

- B. Pumps indicated on the drawings shall have variable speed drive to provide flow modulation. Drive shall be mounted on Mechanical Room wall. Drive shall have voltage vector control, soft switching technology, automatic energy optimization, full English multi-line operators panel with hand/off/auto function, built-in line reactors for harmonic mitigation, main power disconnect with fusing, drive disconnect, manual bypass, isolation barriers inside cabinet, and under voltage/single phase protection. Drive shall send alarm signal to DDC control system in the event of drive failure. **Controls and interface to BAS shall be in accordance with Article 230510 Controls.**

#### 230508 AIR & DIRT SEPARATORS

- A. Subject to compliance with requirements, provide products by the following: Spirotherm VDT, Bell & Gossett, TACO, or Armstrong. Separator shall be coalescing-type without removeable head. Coalescing medium shall be copper or stainless steel. Tank shall be welded steel, ASME constructed, and labeled for 125-psig minimum working pressure and 270 deg F maximum operating temperature, with tangential inlet and outlet connections threaded for NPS 2 and smaller and Class 150 flanged connections for NPS 2-1/2 and larger, and automatic air vent. Heating and Air Conditioning Contractor shall provide piping from air separator's blowdown connection to nearest floor drain. Size separator to match system flow capacity.

#### 230509 VALVES

- A. Valves shall be furnished as specified and as shown on the plans. All valves shall have manufacturer's metal identification disc under the handle nut. Provide valve extension handles for all valves in chilled water piping system. Seats for iron body valves shall be renewable. Valves shall be by a single manufacturer unless noted otherwise.
- B. Check valves up to 2-1/2" shall be bronze body swing check with Teflon disc and stainless trim. Check valves 3" and over shall be the wafer non-slam type with ductile iron body, 316 stainless steel trim, bronze bushings, and bronze seats.
- C. Ball valves shall have bronze body, synthetic rubber seat rated at 250°F, ball and seat and indicating dial with memory stop. Valves on chilled water system shall have stem extensions for insulation coverage.
- D. Butterfly valve shall have ductile iron lug body, aluminum bronze disc, synthetic rubber seats rated at 250°F, ductile iron or aluminum lock handle with memory stop. Valves 6" and larger shall be equipped with gear operator with handwheel. All gear operators shall have traveling indicator and adjustable stops. Valves shall have stem extensions for insulation coverage.

#### SIZES UP TO AND INCLUDING 2-1/2" BRONZE BODY SCREW IN

	<u>BALL</u>	<u>CHECK</u>
Hammond	8201	IB 946
Nibco	T-580	T-433-Y
Milwaukee	BA-200	510T

SIZES 3" AND OVER FLANGE CONNECTED IRON BODY

	<u>CHECK</u>	<u>BUTTERFLY</u>
Hammond	9354	6200
Nibco	F-910	LD-3100
Milwaukee	1800	ML-122B

- E. Multipurpose valves shall be straight pattern design to perform functions of non-slam check valve, throttling valve, shutoff valve and calibrated balancing valve. Valve shall be cast iron suitable for 175 PSI working pressure with bronze seat, replaceable bronze disc with EPDM seat insert, stainless steel stem, and chatter preventing stainless steel spring. Valves shall be Bell and Gossett, Armstrong, or Taco.

230510 CONTROLS

A. General:

1. Furnish and install new controls as necessary for chillers and pumps operation and fully connected to and integrated with the building's **existing Schneider Electric Andover DDC system** to fulfill the intent of the drawings and specifications, including DDC graphics. The systems shall include all necessary labor, electrical wiring, devices, and materials for a complete installed control system.
2. All electric wiring in connection with the temperature controls and all interlock wiring shall be furnished under this section of the specifications. The wiring shall be installed by licensed electricians employed by, or subcontracted by, the Mechanical Contractor, in strict accordance with all Local, State and National Codes. All control and interlock wiring shall be in accordance with the Electrical Division, Division 26, of these specifications.
3. The existing building control system will energize the new chillers. The new chillers shall energize the existing chilled water pump.
4. The control system shall be complete with all necessary relays, switches, accessories, etc., and all interconnections so arranged that there will be the proper automatic sequence in operation between the various control devices required to maintain the desired temperature or conditions.
5. The exact location of instruments, panelboards, accessories, etc., not definitely located shall be approved by the Owner or his representative. All automatic controls and accessories shall be located in accessible locations. All non-panel, as well as panel mounted instruments, shall be clearly labeled as to use, position and system served by means of engraved phenolic nameplates.

B. Sensing Equipment:

1. Flow Switch: Switches are integral to the chiller.
2. Immersion Thermostats: Shall have remote outdoor liquid filled bulb to provide a signal for energizing and deenergizing equipment. Thermostats shall be mounted in an accessible weather protected area and shall have dial temperature setting range.

C. Control Equipment:

1. Relays shall have 120-volt coil suitable for controlled load.
2. Switches shall be twist type with pointer extending through the panel's face.

D. Control Panels:

1. Furnish and install as shown on the plans a wired control.
2. All wiring shall be neatly bundled, labeled, and wiring shall be terminated inside the cabinet at labeled wiring terminals.
3. Engraved Bakelite nametags shall be provided for each panel mounted device whether inside the cabinet or mounted on the panel's face.
4. All relays, controllers, switches, and accessories shall be mounted in the control panels. Switches shall be mounted in the panel's face.
5. All line voltage wiring and terminals shall be covered with insulated guards for the protection of service personnel even with the control panel open.

E. Shop Drawings:

1. The Mechanical Contractor shall submit the following for approval:
  - a. A diagram of each control system that shall indicate the proper sequence of operation for all operating modes.
  - b. A complete description of the automatic operation of each control system. The description shall indicate the duty of each switch, relay, etc., incorporated in the control system.
  - c. A schedule and illustration of all control instruments and equipment, including the control panels.
  - d. Shop drawing of the control panel and a description of all functions.

F. Sequence of Operation:

1. Chillers shall be controlled by the existing BAS system and flow switch at the chillers. See chillers specification for details.
2. The chillers has their own internal built-in flow switch. Additional wiring is required from the chilled water pump starter to the chillers as a secondary safety to the chillers's flow switch to insure that water is flowing to the chillers at all times. This is required only for a flooded evaporator chillers design

G. Instructions and Diagrams:

1. The Mechanical Contractor shall provide to the Owner a complete instruction manual covering the function and operation of all control components. The manuals shall also contain a schematic drawing of cooling tower and chillers control system properly marked and keyed with the equipment list to identify each item of control equipment.
2. The Mechanical Contractor shall also provide a complete schematic control diagram framed under glass and mounted on the wall in the equipment room.
3. The Mechanical Contractor shall provide a minimum of eight (8) hours on-site training on the control system for the chillers. This training shall be conducted by a competent representative of the Mechanical Contractor. Training shall include a complete review of the control system, control component or devices and their locations, control functions with demonstration, and safety shutdown functions.

230511 WATER TREATMENT

- A. Flushing of new chilled water piping and equipment shall be by the Heating and Air Conditioning Contractor. Flushing shall be coordinated with Cape Fear Community College's Chemical Treatment Contractor.
- B. Chemical cleaning and treatment including chemicals will be by Cape Fear Community College's Chemical Treatment Contractor as contracted directly by Cape Fear Community College.

230512 HEAT TRACE CABLE

- A. See drawing for detail and specification of heat trace cable. Heat trace cable shall be installed on all exterior above grade water piping, valves, etc. at the chillers.

230513 ELECTRICAL

- A. Electrical circuit sizes are based on capacities of the drawings and it shall be the responsibility of Mechanical Contractor to change any and all electrical work in order to fit the new mechanical equipment. The Electrical Contractor shall be a subcontractor the Mechanical Contractor and shall check all electrical work to assure that all units are properly connected and shall check wiring prior to starting units. Any damage to units resulting from improper wiring or connections shall be the responsibility of Mechanical Contractor. All electrical work shall be installed in accordance with codes having jurisdiction and the Electrical Division, Division 26, of these specifications.
- B. All three phase motors shall be provided with phase loss protection.
- C. Starters shall have integral 120V Control power transformer. Starters shall have holding coil for 120V control with hand-off-auto switch. The starters shall be inoperative if the thermal unit is removed. All magnetic starters shall be NEMA sized with applicable melting alloy overload relays and applicable enclosure. Starters shall be GE or approved equals by Allen-Bradley, Square D, Siemens or Cutler-Hammer.
- D. Fused disconnect switches shall be per the Electrical Division, Division 26, of these specifications.
- E. Motor Starters and Fused Disconnect Switches shall be neatly arranged, and securely fastened to walls with expansion bolts, lead shields, etc. Each starter or switch shall have its usage or letter designation indicated on its cover per the Electrical Division, Division 26, of these specifications.

230514 PIPING

- A. The Mechanical Contractor shall furnish all piping and supports necessary to provide a complete system as shown or intended by the plans and specifications. All piping shall be inspected, tested, and approved before being insulated or concealed. Piping 2" and smaller shall be welded or have screwed fittings with extra heavy nipples, unless otherwise noted. Piping 2-1/2" and larger shall have welded fittings of the same material and weight as the piping in which they are installed. Pipe shall be clean, run generally parallel to the building and have all open ends closed with iron caps at all times. Eccentric reducers shall be used in horizontal runs and concentric reducers in

vertical runs. All piping and fittings shall have manufacturer's identification and ASTM designation incorporated thereon.

- B. Chilled water piping shall be standard weight Schedule 40 black steel in accordance with ASTM Specification A-53. All fittings shall be Schedule 40.
- C. Make-up water piping shall be Type L copper with all joints soldered with 95-5 solder. Piping shall have dielectric union at connection to ferrous pipe.
- D. Welding material and labor shall be in accordance with welding procedures of the American Standards Code for Pressure Piping ASA B31.9. Welders shall be fully qualified in above specified procedure, tested, and so certified by an approved Welding Bureau of Locally Recognized Testing Authority. Welding shall be electric arc or oxyacetylene welding method as approved using electrodes and rods that comply with ASTM specifications.
- E. Swing joints or loops shall be provided wherever necessary to allow for expansion of piping. Broken piping or fittings shall be removed and replaced at the Mechanical Contractor's expense.

#### 230515 PIPE HANGERS

- A. All piping shall be neatly and securely supported by hangers from fire resistance rated structural elements and shall be spaced in the following manner:
  - 1. Steel Piping 1-1/4" and smaller – 7'-0" OC.
  - 2. Steel Piping 1-1/2" and smaller – 10'-0" OC.
  - 3. Copper Piping 1-1/4" and smaller - 6'-0" O.C.
  - 4. Copper Piping 1-1/2" and larger - 10'-0" O.C.
  - 5. Provide 2 hangers at each change in direction.
- B. Hangers shall be the Clevis type as manufactured by Modern Fig. 590, B-Line Fig. B 3100, or Anvil Fig. 260 complete with hanger rods of size to conform to the type of hanger and pipe supported. Hangers shall be attached to the building by beam clamps or bolted to bar joist. At hangers provide 16" long 16 gauge galvanized sheet metal protection saddle three times the nominal pipe diameter. Under no condition shall hangers be connected directly to insulated pipe. Saddles shall be Modern Type A, B-Line Fig. B 3151, or Anvil Fig. 167.
- C. Hangers for vertical piping shall be riser clamp design as manufactured by Modern Fig. 500, B-Line Fig. B3373 or Anvil Fig. 261. Riser clamps shall be installed on top of each floor penetration.

#### 230516 INSULATION

- A. All piping shall be inspected and tested before insulation is applied. All insulation shall meet UL 723 and ASTM-E84 flame spread and smoke developed requirements of 25/50 and shall comply with NFPA 90A and the latest edition of the NC Building Code. Insulation shall be Certainteed, Owen Corning, Knauf, Johns-Manville, Trymer, Hi-Therm, or Dyplast.
- B. All new chilled water supply and return piping, fittings, valves, etc., shall be insulated with rigid 2.3 lb/cubic feet phenolic insulation with a thermal conductivity of 0.15 btu-in/hr-ft<sup>2</sup>-°F or lower at 75°F equal to Trymer Green, Hi-Therm, or Dyplast DyTherm. Insulation and vapor retarder



shall not exceed a ASTM E-84 flame/smoke rating of 25/50. Provide Saran 540 vapor retarder film factory applied and Saran vapor retarder tape field applied. All butt and longitudinal joints shall be sealed. Fittings and valves shall be insulated with pre-formed phenolic fittings or mitered sections of pipe covering and covered with Saran 520 tape. Fiberglass fittings will not be permitted. Provide a 24" section of insulation for each pipe hanger to be installed by Mechanical Contractor at time pipe hanger and pipe are installed. Install insulation in such a manner as required to provide a complete vapor barrier. Piping insulation thickness shall be as shown in the schedule on the drawings. All piping and fittings shall be clean and dry prior to installation of the insulation.

1. All insulation shall be tightly butted and free of voids and gaps. Vapor Retarder must be continuous. All fasteners and bands shall be neatly aligned and overall work must be of high quality appearance and workmanship.
  2. In below ambient systems, staples, rivets, screws and other fasteners capable of penetrating the vapor retarder shall not be used.
  3. Lap joint of vapor retarder to be sealed using SSL tape. Vapor retarder butt joints shall be covered with Saran 520 Vapor Retarder Tape. Vapor retarder butt joints shall be covered with a single layer of Saran 520 Tape.
  4. Elbows and fittings shall be wrapped with Saran 520 Vapor Retarder Tape in a spiral fashion. Use a minimum amount of overlap between successive courses of spiral wrapped Saran Tape.
  5. Insulation sections in hangar saddles shall be phenolic for pipes less than 16 NPS. At 10 feet hangar spacing and on pipes 16 NPS and larger, the bottom insulation sections in hanger saddles shall be 3.75 lb. per cubic foot rigid phenolic foam insulation for resistance to compression. Saddles shall wrap the insulation in an arc between 120° and 180°F depending upon the load.
  6. When Saran vapor retarder film is used without PVC jacketing, a 1"-wide or greater filament tape or Saran 520 tape with a 25% (1-1/4 wraps) circumferential overlap shall be wrapped around the outside of the Saran 540 vapor retarder on 12" centers.
- C. Air separators shall be insulated with same insulation material and thickness as connected piping. Chilled water system pumps shall be insulated with 1-1/2" thick blocks of 2.3 lb/cu ft. density phenolic rigid foam insulation with vapor retarder. Insulation shall be secured with stainless steel straps.
- D. Insulation on pumps shall be formed such that it can be removed and reinstalled for pump servicing.
- E. Make-up water piping shall be insulated with tubular closed cell elastomeric insulation with all joints butted and cemented tight. Insulation on make-up water piping and interior condensate piping shall be 1" thick.
- F. All exterior hydronic piping insulation shall be provided with a protective aluminum jacket with a factory-applied poly backing moisture barrier. Aluminum jackets shall be cross-crimped (longitudinally corrugated) for strength. Aluminum jackets shall be not less than 0.016" thick and shall be secured with aluminum or stainless steel screw; not more than 8" apart. Each jacket shall be applied by turning a 1" hem inward on one longitudinal edge and then lapping the hemmed edge over the unhemmed edge. The jacket may be machine cut to produce a straight smooth edge and the hem omitted. The longitudinal and circumferential seams shall be lapped not less than 2". Jackets on horizontal lines shall be so installed that the longitudinal seams are

on the bottom half of the pipe with the seam of each jacket slightly offset from the seam of the adjacent jackets; top edge shall overlap bottom edge. The jackets on vertical lines and lines pitched from the horizontal shall be installed from low point to high point so that the lower circumferential edge of each jacket overlaps the jacket below it. Special fitting jackets conforming to the above with the exception of longitudinal lapping dimensions and location of seams shall be used for fittings, valves, and flanges. Jackets for fittings, valves, and flanges shall be properly overlapped and secured. Equivalent aluminum jacketing system, when approved, will be acceptable.

#### 230517 SPECIALTIES

- A. Thermometers (9" long) and gauges (4-1/2" dial) shall have white backgrounds and black numerals and graduations with red non-mercury and non-alcohol indicating fluid. Ranges shall be selected to indicate operating conditions at mid-scale. Accuracy shall be within 1-1/2% of scale range. Pressure gauges shall be compound. Mounting provisions shall provide for insertion of well with separable socket into piping at an angle to permit reading from the floor and shall be of adequate length to project through insulation. Thermometers and gauges shall be Bitmet, Mueller, Taylor, or approved equal. Gauges shall have shut-off cocks.
- B. Air vents shall be provided at all points on the piping systems where required to eliminate air from the system. The air vents shall be manual or high capacity automatic type as indicated and manufactured by Bell and Gossett, Hoffman or Armstrong.
- C. Strainers shall be screwed (2" and smaller) or flanged (2-1/2" and larger), Y type, 125 pounds, with removable stainless steel screen and shall be provided with close-nipple blowout and ball valve on discharge side. Screen perforations shall be suitable for water flow as appropriate. Screen perforations in strainers at chillers shall be per chillers manufacturer's installation requirements.
- D. Pressure reducing valves shall have body and all working parts of brass and built in strainer. Valve shall be Bell and Gossett, Taco or Sarco.
- E. Pressure relief valve shall be ASME and NB approved with setting and capacity as shown on the drawings or as required. All working parts shall be of non-ferrous metal. The valves shall be Bell and Gossett, Taco, or Sarco.
- F. Unions or flanges shall be provided throughout the piping system to facilitate the removal and servicing of all valves, equipment, items, etc.
- G. Pressure and temperature taps shall be 1/4" MPT fitting to receive either a temperature or pressure probe 1/8" OD. Fitting shall be solid brass with two valve cores of Nordel (Max 275°F) at 500 PSI, fitted with a color-coded cap strap with gasket, and shall be rated at 1000 PSIG at 140°F. Temperature and pressure probe readout kit shall be delivered to Owner for maintenance use.
- H. Flexible connectors shall be provided in piping connections to pumps. Flexible connectors shall be annular, close pitch hose of stainless steel with stainless steel braid. End fittings shall be male pipe thread or 150 lb. flange as necessary for mating equipment and piping.

230518 PAINTING

- A. Insulation on piping and equipment in mechanical equipment rooms shall be finished and painted with two coats of gloss enamel. Painting shall be primed as necessary. Color shall be as follows:
1. Chilled Water Supply and Return Piping – Medium Blue – match existing.
  2. Make-Up Water – Light Blue – match existing.
  3. All Ferrous Valves, Hangers, and Supports - Black.

230519 PIPE MARKERS

- A. Markers shall have wording, wording colors, and wording background in accordance with ANSI A13.1. Markers shall have letters approximately 1" high on appropriate background, flow arrows, and shall be located on pipe at intervals not exceeding 10'-0". Markers shall be plastic with markers on piping completely encircling the pipe with overlap and permanent tension in the marker to grip the pipe firmly with the need of adhesives. Wording of markers shall be as follows:
1. Chilled Water Supply - Chilled Water Return.
  2. Make-Up Water.
  3. Piping with heat trace cable shall have appropriate warning labels on insulation cover or protective aluminum jacket.

230520 NAMEPLATES

- A. Chillers and new pumps shall be furnished with engraved plastic laminated labels permanently attached to the equipment. Lettering shall be ½" tall. Label shall include equipment number, area served, final acceptance date, and capacities. Final acceptance date shall be on a separate label so as to allow equipment nameplates to be installed prior to final acceptance.

230521 CUTTING AND PATCHING

- A. The Mechanical Contractor shall do all cutting and patching necessary to install all equipment as required under his contract in accordance with the General Conditions of these specifications and shall re-establish all finishes where cutting and patching occur to their original condition. All cutting of the structure, where unavoidable, must be approved by the Engineer.

230522 FOUNDATIONS

- A. All concrete and reinforcing steel for foundation slabs under equipment shall be provided by the Heating and Air Conditioning Contractor. Foundations shall extend beyond all equipment by 4" in all directions and shall be made from 3,500 PSI concrete reinforced with 10/10 x 6/6 wire mesh. Foundation surfaces shall be troweled smooth and edges shall be tooled. Equipment pads shall be painted OSHA approved yellow.

230523 PIPING PRESSURE TESTING

- A. The Mechanical Contractor shall make the following tests before the systems are insulated or covered by construction. The systems shall have no decrease in pressure during the test periods.

All system components shall be protected from test pressures that exceed manufacturer's design limits.

- B. Notify Engineer and Commissioning Authority 48 hours in advance of all tests.
- C. New chilled water piping shall be tested by applying a hydrostatic pressure of 150-PSIG for a period of four (4) hours. Chillers and existing piping shall be isolated during testing.
- D. New make-up water piping shall be tested by applying a hydrostatic pressure of 100-psig for a period of two hours.
- E. No caulking of joints shall be permitted. Any joint found to leak under this test shall be broken, remade, and a new test applied. Welded joint pinhole leaks shall be repaired by welding; however, welds that show numerous pinholes shall be replaced.

#### 230524 TESTING AND BALANCING

- A. Testing, adjusting, and balancing of the mechanical systems shall be directly subcontracted to an AABC or NEBB certified TAB Contractor by the Mechanical Contractor and shall be certified by that TAB Contractor.
- B. Mechanical Contractor shall be responsible to coordinate and cooperate with the TAB subcontractor to facilitate and complete testing, adjusting, and balancing of the mechanical systems.
- C. Mechanical Contractor shall make any changes in the valves, etc. necessary or as recommended by the Engineer for correct balance at no additional cost to the Owner.
- D. Flow to new chillers and pumps shall be balanced to within 5% of design requirements. Record all data, including all motor and drive data for pumps.
- E. Upon completion of the chilled water system, the Mechanical Contractor shall compile the test data and submit three copies of the completed to the Engineer for evaluation and approval.

#### 230525 INSTRUCTIONS/TRAINING

- A. The Mechanical Contractor shall give an eight hour instruction and training period in the operation of the new apparatus to the persons who will be in charge of the system.

#### 230526 MAINTENANCE DATA

- A. For all new items requiring maintenance, the Mechanical Contractor shall furnish two weeks prior to Final Acceptance and deliver to the Owner's representative on the job three copies of complete data as prepared by the manufacturer covering the details of operation and maintenance and complete parts list for all equipment specified. Each copy of the maintenance data shall be assembled into a 3-ring hardback binder with indexing and label on cover and spine. Data shall include:
  - 1. Index with page numbers.
  - 2. List of all subcontractors and suppliers with names, addresses, and phone numbers.

3. Contractor's certificate of Final Acceptance.
4. Copy of all warranties.
5. Equipment model numbers, etc. indicated and referenced with the same mark as shown on equipment on the drawings.
6. Filter schedules of sizes and quantities for all equipment requiring filters referenced by mark on the drawings.
7. Equipment summary showing all capacities and ratings.
8. Certified test and balance report.
9. Start-up and test reports for equipment.
10. Complete start-up, operation, and shut-down procedures for each system.
11. Lubrication schedules and types of lubricates.
12. All submittal data and shop drawings, unless included in a separate manual.

230527 RECORD DRAWINGS

- A. The Mechanical Contractor shall maintain "during the course of the work" a set of specifications and drawings marked up to show the work as installed. Upon completion of the work, return this set of drawings to the Engineer.

230528 GUARANTEE

- A. The Mechanical Contractor shall guarantee the entire new chillers system subject to the General Conditions and these specifications. See chillers specifications for chiller warranty requirements.

END OF SECTION 230500

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## SECTION 260000 – ELECTRICAL, BASICS

### 1.1 RELATED DOCUMENTS

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

### 1.2 GENERAL

- A. Applicable requirements of any Instructions to Bidders, General Conditions of the Contract, and/or Supplemental Conditions shall be a part of the Electrical Specifications. The electrical contractor shall examine all contract documents before submitting a proposal.
- B. The electrical work shall be performed by an electrical contractor, suitably licensed for the scope of work of this specific project.
- C. The electrical contractor shall assume total responsibility for any portion of the work provided by his subcontractors.

### 1.3 CODES AND STANDARDS

#### A. Building Codes:

1. National Fire Protection Association No. 70, National Electrical Code (NEC)
2. North Carolina State Building Code, Latest Edition and Revisions (NCSBC)
3. North Carolina State Fire Code, Latest Edition and Revisions
4. National Electrical Safety Code (NESC)
5. National Bureau of Standards (NBS)
6. Local Codes where applicable

#### B. Industry Standards:

1. Underwriter's Laboratories, Inc. Standards and approved listings (UL)
2. Electrical Testing Laboratories Standards (ETL)
3. National Electrical Manufacturers Association Standards (NEMA)
4. Insulated Power Cable Engineers Association Standards (IPCEA)
5. American National Standards Institute (ANSI)
6. American Society for Testing Materials Standards (ASTM)
7. Canadian Standards Association (CSA)

### 1.4 QUALITY ASSURANCE

- A. Electrical materials, equipment, devices, fixtures, etc. shall be listed and labeled by a third-party agency that is accredited by the NCBC (North Carolina Building Code Council) to label electrical & mechanical equipment. This paragraph applies to all electrical specification sections under specification divisions 26, 27, and 28.

## 1.5 SCOPE OF WORK

- A. It is the intent and meaning of the drawings and specifications to call for finished work that has been tested and is ready for operation. The electrical contractor shall take this into consideration and include in his proposal allowance for contingencies that will allow him to provide minor pieces of materials and labor not specifically indicated but required for the job to operate properly. This paragraph is intended to insure that a complete job will be provided without requests for minor extras.
- B. It shall be understood that where the words “furnish,” “provide,” and/or “install” are used, it is intended that this CONTRACTOR shall purchase and install completely all material necessary and required for this particular item, system, equipment, etc.

## 1.6 RECORD DRAWINGS

- A. A set of drawings covering the electrical contract will be provided to the electrical contractor to mark in color all changes, modifications, or revisions effected during construction. These field mark-up drawings are to be turned over to the electrical designer.
- B. The electrical contractor shall provide final installed photographs of switchboards and panelboards. Photographs shall clearly show equipment designations, manufacturer nameplates, breaker positions, breaker ratings, and directory descriptions.

## 1.7 APPROVAL OF MATERIALS

- A. Construction phase: The CONTRACTOR shall submit his proposal on the specified materials and equipment, or their equivalent, provided the words "or equal" or "or approved equal" follow the named manufacturers. If the above phrases do not appear, the specified manufacturers shall be furnished without substitution. Equivalent shall be interpreted to mean an item of material or equipment, similar to that named and which is suitable for the same use and capable of performing the same functions as that named, with the Design Team being the judge of equality.
- B. Where no specific material or equipment type is mentioned, any first-class product of a reputable manufacturer may be used provided it conforms to the requirements of the specifications.

## 1.8 SHOP DRAWINGS AND SUBMITTAL DATA PROCEDURES

- A. The CONTRACTOR shall submit PDF files of shop drawings, certified prints, literature, and product data sheets to the Design Team for all major items of equipment and materials for review and approval. It is preferred that all electrical submittals for the project shall be submitted at one and the same time.
- B. Product data sheets with multiple components, part numbers, etc. shall be clearly marked to identify what specific product/model/part number is proposed for this project.
- C. The CONTRACTOR shall analyze all shop drawings and submittal data and certify that they meet requirements of Contract Drawings and Specifications, prior to delivery to the Design



Team. CONTRACTOR Certification shall be in the form of suitable approval stamp placed on each shop drawing/submittal submitted.

1. If the shop drawings or submittal data deviate from the Contract Documents, the CONTRACTOR shall advise the Design Team of deviations in writing, accompanying the shop drawings and submittal data, including the reason for deviations.
- D. If the Design Team deems submittal data is either incomplete or incorrect, a resubmittal will be required. Where a resubmittal is not necessary but confirmation of receipt of review comments is requested, confirmation shall be submitted in writing.
- E. At least one set of all final submittal data, shop drawings, certified prints, etc., shall be maintained at the job site and available to representatives of the Design Team.
- F. Approval by the Design Team of shop drawings and submittal data is for general conformance with the contract documents and design concept.
1. Such approval does not relieve the CONTRACTOR of responsibility for compliance with the project drawings and specifications.
  2. Such approval for any materials, apparatus, devices, and layouts shall not relieve the CONTRACTOR from the responsibility of furnishing same of proper dimensions, size, quantity, quality and all performance characteristics to efficiently complete the requirements and intent of the contract documents.
  3. Such approval shall not relieve the CONTRACTOR from responsibility for errors of any sort on the shop drawings.
- G. Physical sizes of equipment used in the design layout are those of reputable equipment manufacturers. The CONTRACTOR is responsible for providing equipment that will fit the space available. If the CONTRACTOR elects to use equipment that results in conflicts with space clearance or codes, it shall be the responsibility of the CONTRACTOR to correct at his expense. The CONTRACTOR shall be responsible for providing code clearances. Where equipment is designated for existing space, the CONTRACTOR shall make necessary field measurements to ascertain space requirements, including those for connections; and shall furnish and install such sizes and shapes of equipment that the final installation shall suit the intent and meaning of the drawings and specifications.
- H. Catalog Data for OWNER:
1. The CONTRACTOR shall provide compilations of catalog data, bound in suitable loose-leaf binders, for each manufactured item of equipment used in the electrical work. These shall be presented to the Design Team for transmittal to the OWNER before the final inspection is made. Data shall include printed installation, operation, and maintenance instructions for each item, indexed by product with heavy sheet dividers and tabs. All warranties shall be included with each item. Each manufacturer's name, address, and telephone number shall be clearly indicated. Generally, shop drawings and submittal data alone are not adequate for catalog data.
- I. Record Documents for OWNER:
1. Conductor and cable megger test results.
  2. Field mark-up as-built drawings.

## 1.9 DRAWINGS AND SPECIFICATIONS

- A. The Electrical drawings and specifications are complementary each to the other, and what may be called for by one shall be as binding as if called for by both. The drawings are diagrammatic and indicate generally the location of outlets, devices, equipment wiring, etc and show the general arrangement of raceways, fixtures, and equipment. Drawings shall be followed as closely as actual building construction and the work of other trades will permit; however, all work shall suit the finished surroundings and/or trim.
- B. Any omission from either the drawings or the specifications are unintentional, and it shall be the responsibility of the CONTRACTOR to call to the attention of the Design Team any pertinent omissions before submitting a proposal. Complete and working systems are required, whether every small item of material is shown and specified or not.
- C. The electrical work shall conform to the requirements shown on all of the drawings. General and Structural drawings shall take precedence over Electrical Drawings. Because of small scale of the electrical drawings, it is not practical to indicate offsets, fittings and accessories that may be required. The CONTRACTOR shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings and accessories as may be required to meet such conditions, without additional cost to the OWNER and as directed by the Design Team.
- D. Load circuits shall be installed as indicated on the drawings. Circuit number revisions will not be accepted unless approved in writing by the Engineer.

## 1.10 COORDINATION OF WORK

- A. It is understood and agreed that by submitting a proposal, the CONTRACTOR has, by careful examination, satisfied himself as to the nature and location of the work, the conformation of the ground, the character, quality and quantity of the materials to be encountered, the general and local conditions and all other matters which can and may affect the work under this contract. The CONTRACTOR shall be held responsible for visiting the site and thoroughly familiarizing himself with the existing conditions and also any contractual requirements as may be set forth in other divisions of the specifications and in other contract documents. No extras will be considered because of additional work necessitated by obvious job conditions that are not indicated on the drawings.
- B. The CONTRACTOR shall compare the electrical drawings and specifications with the drawings and specifications for other trades and shall report any discrepancies between them to the Design Team. If needed, request from the Design Team written instructions for changes necessary in the electrical work. The electrical work shall be installed in cooperation with other trades installing interrelated work. Before installation, the CONTRACTOR shall make proper provisions to avoid interferences in a manner approved by the Design Team. All changes required in the work of the CONTRACTOR caused by his neglect to do so shall be made by him at his expense.
- C. Location of electrical raceways, switches, panels, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The CONTRACTOR

shall determine the exact route and location of each electrical raceway prior to make up and assembly.

- D. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example; steam, condensate and plumbing drains shall normally have right of way. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed.
- E. Offsets and changes in direction of electrical raceways shall be made as required to maintain proper headroom and to clear pitched lines whether or not indicated on the drawings. The CONTRACTOR shall furnish and install elbows, pull boxes, etc., as required to affect these offsets, transitions, and changes in directions. Conflicts between electrical raceways, fixtures, etc., and ductwork which cannot be resolved otherwise, will be resolved by the Design Team.
- F. The CONTRACTOR shall install all electrical work to permit removal (without damage to other parts) of any equipment requiring periodic replacement or maintenance. The CONTRACTOR shall arrange electrical raceways and equipment to permit ready access to valves, cocks, traps, starters, motors, control components, etc., and to clear the opening of swinging and overhead doors and of access panels.
- G. Work at Existing Facilities:
  - 1. Where work may be required to be performed at existing and/or occupied facilities, such work shall be scheduled and arranged to be done at the convenience of the OWNER so as not to interfere with, disrupt, or disturb normal operations at the facilities. The CONTRACTOR shall obtain written approval from the OWNER before proceeding with work at existing facilities and shall work at existing facilities on schedule as agreed upon with the OWNER. This is not to be necessarily construed to mean that the CONTRACTOR is expected to perform work at existing facilities on holidays, weekends, etc., but that the Contractor must schedule work with the OWNER for the OWNER's beneficial and normal usage of the facilities, and that the CONTRACTOR will be required to maintain the schedule as approved by the OWNER.
  - 2. The CONTRACTOR shall, at all times, provide safety barriers, protective devices, screening, dust barriers, etc., as required to maintain the safety and comfort of the building's personnel and/or occupants in or near his work area.
  - 3. The CONTRACTOR shall be responsible for cleanup in connection with his work at existing facilities. At the end of each working day, all debris, boxes, waste, etc. shall be removed from the facilities and properly disposed of. Equipment, materials, etc. may be left inside the facilities, but such must be properly stored, stacked, and located as approved by the OWNER.
  - 4. The CONTRACTOR shall do all cutting, patching, finishing, repairing, painting, etc., necessary for electrical work to be installed at existing facilities. All finishes shall be left to equal finish and condition prior to cutting. No cutting of structural members will be allowed. All cutting of walls, floors, roofs, etc. shall be repaired and/or replaced to a finish equal to that found prior to cutting.
  - 5. The CONTRACTOR shall route conduits and locate equipment as approved by the OWNER and Design Team. Routing and locations shall be firmly established and approved before proceeding with any phase of the work.
  - 6. The CONTRACTOR shall be responsible for any and all damage to the existing facilities, grounds, walkways, paving, etc. caused by the work, the CONTRACTOR and/or his

personnel, and/or his equipment in the accomplishment of this work. Such damages shall be repaired and/or replaced by the CONTRACTOR at his expense, to equal finish prior to damage. The Design Team shall be the judge as to equal finishes, etc.

7. Certain power requirements must be met without interruption during certain times on the existing electrical system. It is anticipated that partial power outages will be necessary to accomplish the work covered by these drawings and specifications. The CONTRACTOR shall determine in advance the dates, times and duration of these outages and shall obtain permission from the OWNER to shut down the electric power. Unauthorized power outages will not be tolerated.

H. Equipment and Materials (General):

1. Materials shall be new and shall bear the manufacturer's name, trade name, and listing label in every case where a standard has been established for the particular material. The equipment to be furnished under this specification shall be essentially the standard product of manufacturers regularly engaged in the production of the required type of equipment and shall be the manufacturer's latest approved design.
2. Electrical motors shall meet the minimum efficiency requirements identified in the Code of Federal Regulations 10 CFR Part 431.
3. Delivery and Storage:
  - a. Store products to allow for inspection and measurement of quantity or counting of units.
  - b. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
    - 1) Electrical equipment shall be delivered to the site and stored in original containers. Store inside dry, heated spaces, but readily accessible for inspection by the Design Team until installed.
    - 2) Rusty and/or corroded materials and equipment will be replaced at the direction of the Design Team.
  - c. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
  - d. Protect stored products from damage.
4. Equipment and materials of the same general type shall be of the same make throughout the work to provide uniform appearance, operation and maintenance.
5. At the completion of work; fixtures, equipment, and materials shall be cleaned and polished thoroughly and turned over to the OWNER in a condition satisfactory to the Design Team. Damage or defects, developing before acceptance of the work shall be corrected at the CONTRACTOR's expense.
6. Manufacturer's directions shall be followed completely in the delivery, storage, protection, and installation of all equipment and materials. The CONTRACTOR shall promptly notify the Design Team, in writing, of any conflicts between requirements of the Contract Documents and the manufacturer's directions and shall obtain the Design Team's written instructions before proceeding with the work. Should the CONTRACTOR perform any work that does not comply with the manufacturer's instructions, recommendations, or requirements; it shall be corrected at his expense as directed by the Design Team.

I. Sleeves, Inserts, Openings, Etc.:

1. Anchor bolts, sleeves, inserts, supports, etc., that may be required for electrical work shall be furnished, located, and installed by the electrical contractor. Where working under a subcontract for a General Contractor, the electrical contractor shall give sufficient information (marked and located) to the General Contractor in time for proper placement in the construction schedule. Should the electrical contractor delay or fail to provide sufficient information in time, the electrical contractor shall cut and patch construction as necessary and required to install electrical work, with finishes completed to the satisfaction of the Owner and the Design Team.

J. Cutting and Patching:

1. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. The electrical contractor shall be responsible for cutting and patching as required for the proper installation of electrical work for this project. Cutting shall be kept to a minimum. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Finishes shall be restored to the satisfaction of the Owner and the Design Team.

K. Locations and Measurements:

1. Outlets, equipment, fixtures, etc. are shown and located on the drawings as intended based on the Design Team's understood project scope. All measurements for installation shall be verified on the project and coordinated with the drawings of other disciplines. In all cases, work shall suit the surrounding trim and/or decoration and construction. The locations of outlets for appliances shall be installed so that when connected they permit the proper installation of appliances. Slight relocations of outlets, devices, and equipment shall be made by the electrical contractor as required or as directed by the Design Team at no additional cost to the OWNER.

L. Workmanship:

1. Work shall be executed as required by the drawings and specifications, shall be done in a workmanlike manner by skilled mechanics, and shall present a neat, trim, and mechanical appearance when completed. All work shall be performed as required by the progress of the job.

M. Final Inspections and Equipment Demonstrations:

1. The CONTRACTOR shall acquire permits for construction & coordinate all required inspections with the office of the local electrical inspector and/or local authority having jurisdiction, if required. The CONTRACTOR shall provide the Owner two (2) copies of Electrical Inspectors' written reports.
2. The CONTRACTOR shall furnish ladders, required tools, and personnel to open equipment, fixtures, boxes, panels, etc. to enable the Design Team representatives to observe any parts of the installation they may request.
3. The CONTRACTOR shall furnish meters for observation of readings as directed by the Design Team representative. Meters to be furnished include: clamp-on type ammeter, voltmeter, insulation resistance tester (i.e., often called a megger), and clamp-on type ground resistance tester.

N. Operating Instructions:

1. At the completion of the entire installation, the CONTRACTOR shall arrange to operate each component of systems and then systems as a whole. When all the requirements of the plans and specifications have been met, the CONTRACTOR shall then arrange to instruct the OWNER's operating and maintenance personnel in the correct and proper procedures for the operation and maintenance of the systems

END OF SECTION 260000

## SECTION 260500 - BASIC ELECTRICAL MATERIALS AND METHODS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Supporting devices for electrical components.
  - 2. Cutting and patching for electrical construction.
  - 3. Touchup painting.
  - 4. Electrical demolition.

#### 1.3 SUBMITTALS

- A. Product Data:
  - 1. Support channels and hardware.

#### 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

### PART 2 - PRODUCTS

#### 2.1 SUPPORTING DEVICES

- A. Metal Items for Use Indoors: Plain Steel.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
- D. Aluminum Slotted Support Systems: Preformed aluminum channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
- E. Slotted Support Systems Fittings and Accessories: Products of the same manufacturer as channels.
- F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

- G. Expansion Anchors:
  - 1. Inside: Carbon-steel wedge or sleeve type.
  - 2. Outside: Hot-dip galvanized steel wedge or sleeve type.
- H. Toggle Bolts:
  - 1. Inside: All steel springhead type.
  - 2. Outside: Hot-dip galvanized steel springhead type.

## 2.2 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
  - 1. For re-finishing existing disconnects: Seal, prime, and provide 2 coats of paint.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

## PART 3 - EXECUTION

### 3.1 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange during progress of construction to facilitate the electrical installations that follow.
  - 1. Set inserts, sleeves, raceways, boxes, etc. in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work.
- C. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.

### 3.2 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

### 3.3 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Selection of Supports: Comply with manufacturer's written instructions.



- B. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load.

### 3.4 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate pipe hangers or clamps.
- F. Install 1/4-inch- diameter or larger threaded hanger rods, unless otherwise detailed.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.
- I. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- J. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- K. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
  - 1. Wood: Fasten with wood screws or screw-type nails.
  - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
  - 3. New Concrete: Concrete inserts with machine screws and bolts.
  - 4. Existing Concrete: Expansion bolts.
  - 5. Steel: Spring-tension clamps on steel.
  - 6. Light Steel: Sheet-metal screws.

7. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

### 3.5 DEMOLITION

- A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- D. Remove demolished material from Project site after coordination with the Owner's representative. Equipment and/or materials that the Owner desires to retain shall be moved to a location designated by the Owner's representative.
- E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

### 3.6 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work.

### 3.7 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint.
  1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
  2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
  3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

### 3.8 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Final Acceptance.

END OF SECTION 260500

## SECTION 260519 - CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field Quality-Control Test Reports: From Contractor.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

#### 2.2 POWER CONDUCTORS AND CABLES

- A. Manufacturers:
  - 1. AFC Cable Systems.
  - 2. Cerro Wire LLC.
  - 3. Colonial Wire and Cable.
  - 4. Encore Wire Corporation.
  - 5. General Cable Corporation.
  - 6. Okonite.
  - 7. Prysmian Group.
  - 8. Republic Wire, Inc.
  - 9. Service Wire.
  - 10. Southwire.
  - 11. Or approved equal.
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

- C. Conductor Material:
  - 1. Copper complying with NEMA WC70 / ICEA S-95-658 solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
  - 2. Power and lighting circuitry: Minimum conductor size shall be #12, and maximum conductor size shall be #500 kcmil.
- D. Conductor Insulation Types: Type THHN/THWN-2 complying with NEMA WC70 / ICEA S-95-658.

### 2.3 CONNECTORS AND SPLICES

- A. Manufacturers:
  - 1. AFC Cable Systems.
  - 2. AMP Incorporated/Tyco International.
  - 3. FCI.
  - 4. Greaves Polaris.
  - 5. Hubbell/Anderson.
  - 6. ILSCO.
  - 7. NSI.
  - 8. O-Z/Gedney; EGS Electrical Group LLC.
  - 9. Penn Union.
  - 10. 3M Company; Electrical Products Division.
  - 11. Or approved equal.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
  - 1. For conductors #8 & smaller, use wire-nut type twist connectors.
  - 2. For conductors #6 & larger, use pre-insulated solderless connectors with one spare port for future cable connection.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Feeders, Branch Circuits: Type THHN/THWN-2, single conductors in raceway.

### 3.2 INSTALLATION

- A. Use manufacturer-approved pulling compound or lubricant where necessary. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- B. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables, conductors, or raceway.
- C. Identify and color-code conductors and cables according to Section "Electrical Identification."
- D. Shared neutral conductors shall not be used unless specifically indicated so on homerun circuitry designations on the drawings.

### 3.3 CONNECTIONS

- A. Connect equipment, outlet, device, and component connections to wiring systems and to ground. 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 tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, a calibrated torque tool shall be used to achieve that indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving required torque.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

### 3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
  - 2. Inspect for physical damage. test conductors and cable for continuity and shorts.
  - 3. Insulation Resistance (Megger) testing for building wire and cable:
    - a. All current carrying phase conductors and neutrals shall be tested as installed, and before connections are made, for insulation resistance and accidental grounds. This shall be done with a 500-Volt insulation resistance tester. Insulation resistance testers shall not be electronic type. Insulation resistance testers shall be hand crank or power-driven crank type. Minimum readings between conductors and between conductor and the grounded metal raceway shall be: 25 mega-ohms for #6 wire and smaller; 50 mega-ohms for #4 wire or larger.
    - b. The CONTRACTOR shall correct malfunctioning conductors and cables, including replacement if necessary, and retest to demonstrate compliance.
    - c. Certify compliance with test parameters.
- B. Test Reports: Prepare a written report to record the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
  - 4. Provide tabulated insulation resistance readings for each panel circuit.
- C. Witness Tests:
  - 1. The CONTRACTOR shall furnish an insulation resistance tester and show Design Team representative and/or Owner that the conductors comply with the specified requirements.

END OF SECTION 260519

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## SECTION 260526 - GROUNDING AND BONDING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

#### 1.3 QUALITY ASSURANCE

- A. Comply with UL 467.

### PART 2 - PRODUCTS

#### 2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Section "Conductors and Cables."

#### 2.2 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

### PART 3 - EXECUTION

#### 3.1 APPLICATION

- A. In raceways, use insulated equipment grounding conductors.
- B. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

#### 3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

- B. Install equipment grounding conductors in all feeders and circuits.

### 3.3 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

END OF SECTION 260526



## SECTION 260533 - RACEWAYS AND BOXES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
  - 1. Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
  - 2. Section "Wiring Devices" for devices installed in boxes.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RNC: Rigid nonmetallic conduit.

#### 1.4 SUBMITTALS

- A. Product Data: For raceways, fittings, wireways, hinged-cover enclosures, and cabinets.

#### 1.5 FIELD CONDITIONS

- A. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

## 2.2 METAL CONDUIT AND TUBING

### A. Manufacturers:

1. Alflex Inc.
2. Allied Tube and Conduit.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Atkore International / Calbrite.
5. Conduit Pipe Products Company.
6. Electri-Flex Co.
7. Gibson Stainless.
8. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
9. Manhattan/CDT/Cole-Flex.
10. Maverick Tube.
11. O-Z Gedney; Unit of General Signal.
12. Patriot Industries.
13. Republic Conduit.
14. Shaw Stainless and Alloy.
15. Wheatland Tube Co.
16. Or approved equal.

B. Rigid Aluminum Conduit: Produced to ANSI C80.5; listed to UL 6A.

C. Rigid Steel Conduit: Produced to ANSI C80.1; listed to UL 6.

D. IMC: Produced to ANSI C80.6; listed to UL 1242.

E. EMT and Fittings: Produced to ANSI C80.3; listed to UL 797.

1. Fittings: Plated-steel, hexagonal, compression type.

F. FMC: Listed to UL 1.

G. LFMC: Listed to UL 360.

H. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

## 2.3 NONMETALLIC CONDUIT AND TUBING

### A. Manufacturers:

1. Allied Tube & Conduit.
2. American International.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Aruco.
5. Blue Diamond Industries.
6. Cantex.
7. Certainteed.
8. Condux International.
9. ElecSYS.
10. Electri-Flex.

11. Heritage Plastics / Atkore International.
12. Kraloy
13. Lamson & Sessions; Carlon Electrical Products.
14. Manhattan/CDT/Cole-Flex.
15. Queen City Plastics.
16. RACO.
17. Southern Pipe, Inc.
18. Spiralduct, Inc./AFC Cable Systems, Inc.
19. Thomas & Betts.
20. Or approved equal.

B. RNC: Produced to NEMA TC 2; listed to UL 651.

1. Schedule 40 and Schedule 80 PVC.

C. RNC Fittings: Produced to NEMA TC 3; listed to UL 514B; match to conduit or tubing type and material.

#### 2.4 METAL WIREWAYS

A. Listed to UL 870.

B. Manufacturers:

1. Austin.
2. B-Line.
3. Hammond/
4. Hoffman.
5. Milbank.
6. Square D.
7. Thomas & Betts.
8. Unity Manufacturing.
9. Or approved equal.

C. Material and Construction: Sheet metal sized and shaped as indicated.

1. Indoors: NEMA 1.
2. Outdoors: NEMA 3R.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

E. Select features as required to complete wiring system and to comply with NFPA 70.

F. Wireway Covers:

1. Indoors: Hinged type.
2. Outdoors: Flanged-and-gasketed type.

G. Finish: Manufacturer's standard enamel finish.

## 2.5 BOXES, ENCLOSURES, AND CABINETS

### A. Manufacturers:

1. Arlington.
2. Austin.
3. B-Line.
4. Cooper Crouse-Hinds.
5. Emerson/General Signal; Appleton Electric Company.
6. Erickson.
7. FSR.
8. Hammond.
9. Hoffman.
10. Hubbell.
11. Milbank.
12. O-Z/Gedney.
13. Peerless.
14. RACO.
15. Robroy Industries.
16. Rose + Bopla.
17. Scott Fetzer Co.; Adalet-PLM Division.
18. Spring City Electrical.
19. Strong.
20. Thomas & Betts.
21. Vynckier.
22. Walker Systems.
23. Woodhead Industries.
24. Or approved equal.

### B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

### C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

### D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

### E. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

### F. Metal Hinged-Cover Enclosures:

1. Interior Locations: NEMA 250, Type 1 with continuous hinged cover, concealed hinge, and flush latch. Finished inside and out with manufacturer's standard enamel.
2. Exterior Locations: NEMA 250, Type 3R galvanized steel with continuous hinged cover and 3-point latch.
3. Removable interior panel.
4. Metal barriers to separate wiring of different systems and voltages.
5. Accessory feet where required or freestanding applications.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

#### A. Outdoors:

1. Exposed: Rigid metal or IMC.
2. Concealed: Rigid metal or IMC.
3. Underground, Single Run: RNC.
4. Underground, Grouped: RNC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. For grounding electrode conductors: RNC Schedule 80.
7. Boxes and Enclosures: NEMA 250, Type 3R.

#### B. Indoors:

1. Exposed, Higher than 10' AFF: EMT.
2. Exposed, Lower than 10' AFF:
  - a. In Electrical Rooms: EMT.
  - b. Elsewhere: Rigid metal or IMC.
3. Concealed: EMT.
4. Underground branch circuits: RNC.
5. Underground feeders: RNC.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
7. Damp or Wet Locations: Rigid metal conduit.
8. For grounding electrode conductors: RNC Schedule 80.
9. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
  - a. Damp or Wet Locations: NEMA 250, Type 4.

#### C. Minimum Raceway Size: 3/4-inch trade size.

#### D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid metal conduit fittings, unless otherwise indicated.

#### E. Do not install aluminum conduits embedded in or in contact with earth or concrete. For direct burial or concrete encasement or penetrations, coat conduit with asphaltum or bituminous type coating.

#### F. EMT shall not be installed where raceway or fittings would be in direct contact with the earth, underground, in/below concrete, exposed to the elements, exposed to severe physical damage, or exposed to severe corrosive influence.

### 3.2 INSTALLATION

- A. Keep raceways a minimum of 6 inches away from runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Section "Basic Electrical Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal raceways within finished walls, ceilings, and floors, unless otherwise indicated.
  - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Conduits installed on the inside face of exterior building walls shall be spaced off the wall surface a minimum of 1/4" using strut-type channel or "clamp-backs".
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
  - 1. Run parallel or banked raceways together on common supports.
  - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
- K. Raceway connectors shall be insulated throat type. If uninsulated throat connectors are installed, use insulating bushings to protect conductors.
- L. Expansion Fittings:
  - 1. Where raceways of any type pass a building or structure expansion joint, a standard expansion fitting shall be provided and installed. Review architectural and structural drawings for locations of expansion joints.
  - 2. Where raceways installed are subject to temperature swings, install expansion fittings spaced in accordance with manufacturer instructions and NFPA 70 requirements.
  - 3. Expansion fittings shall be compatible with the type of raceway being used.
- M. Terminations:
  - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.

2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
  3. Where using boxes with concentric, eccentric, or over-sized knockouts; provide bonding bushings and jumpers. Size bonding jumpers in accordance with NEC Table 250-122, connecting to the box with ground lugs.
- N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Label each end of pull wires with location of opposite end.
- O. Flexible Connections:
1. Use maximum of 24 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for all motors.
  2. Use LFMC in damp or wet locations.
- P. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- 3.3 PROTECTION
- A. Provide final protection and maintain conditions that ensure coatings and finishes are without damage or deterioration at time of Final Acceptance.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
- 3.4 CLEANING
- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.
1. Exposed threads on galvanized conduits and fittings, installed outdoors, shall be coated with galvanizing paint or equivalent protective coating.

END OF SECTION 260533

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## SECTION 260553 - ELECTRICAL IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes electrical identification materials and devices intended to comply with NFPA 70, OSHA standards, and authorities having jurisdiction.

#### 1.3 SUBMITTALS

- A. Product Data:
  - 1. For each electrical identification product indicated.

#### 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70 for color-coding.

### PART 2 - PRODUCTS

#### 2.1 CABLE LABELS

- A. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches.
- B. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.
  - 1. Not less than 6 inches wide by 4 mils thick.
  - 2. Compounded for permanent direct-burial service.
  - 3. Embedded continuous metallic strip or core.
  - 4. Printed legend indicating type of underground line.

#### 2.2 NAMEPLATES AND SIGNS

- A. Engraved Plastic Nameplates and Signs: Engraving stock, plastic laminate, minimum 1/16" thick for signs up to 20 sq. in. and 1/8" thick for larger sizes.
- B. Fasteners for Nameplates and Signs:
  - 1. Two-part epoxy adhesive.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before applying.
- E. Circuit Identification Labels on Boxes: Panel and circuit number.
1. Interior Boxes:
    - a. Exposed: Pressure-sensitive, self-adhesive plastic label on cover.
    - b. Concealed:
      - 1) Pressure-sensitive, self-adhesive plastic label on cover; or
      - 2) Permanent marker on cover, legible in a standing position by Design Team and Owner.
  2. Exterior Boxes:
    - a. Engraved plastic label on cover; and
    - b. Pressure-sensitive, self-adhesive plastic label inside cover.
- F. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines; install continuous underground-line warning tape located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.
- G. Color-Coding of Phase, Neutral, and Ground Conductors: Use the following colors for service, feeder, and branch-circuit phase conductors:
1. 

<u>Configuration</u>	<u>Phase A</u>	<u>Phase B</u>	<u>Phase C</u>	<u>Neutral</u>	<u>Ground</u>
120/240-V, 1 Ph, 3W	Black	Red	N/A	White	Green
120/240-V, 3 Ph, 4W	Black	Orange	Blue	White	Green
120/208-V, 3 Ph, 4W	Black	Red	Blue	White	Green
277/480-V, 3 Ph, 4W	Brown	Orange	Yellow	Gray	Green
  2. For conductors #6 AWG and smaller, factory apply color the entire length of conductors.
  3. For conductors #4 AWG and larger, field apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible

- unwinding. Use 1-inch-wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
4. At each panelboard, a color code legend shall be permanently posted corresponding to the conductors and voltage in that panelboard.
- H. Apply identification to conductors as follows:
1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
  2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
  3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- I. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment. Attached engraved labels with two-part epoxy adhesive. Apply labels for each unit of the following categories of equipment:
1. Switchgear, switchboards, panelboards, electrical cabinets, and enclosures.
  2. Access doors and panels for concealed electrical items.
  3. Disconnect switches and enclosed circuit breakers.
  4. Control devices and push-button stations.
  5. Motor-control centers and motor starters
- Nameplate colors shall be:
1. Blue surface with white core for 208/120-V or 120/240-V equipment.
  2. Black surface with white core for 480/277-V equipment.

END OF SECTION 260553

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