26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1: GENERAL

1.1 Underground Ducts and Manholes

1.1.1 The work included in this section of the construction standards consists of the design requirements for the complete layout and installation of a concrete encased duct system.

1.1.2 All excavation shall meet the current requirements of O.S.H.A. and any other governing federal, state or local authority with regard to trench safety. The project engineer shall require a Trench Safety Plan signed and sealed by a registered Professional Engineer of the State of Texas.

1.1.3 The A/E shall require provisions for a suitable means of containment and abatement of water run-off contaminated construction materials. These procedures shall meet all local, state, and federal regulations and requirements.

1.2 Building Wire and Cable

1.2.1 This section includes building wire and cable rated 600 volts and less.

1.3 Raceways and Boxes

1.3.1 This section of the standard includes minimum design requirements for raceways and boxes used for electrical power, control, and telecommunications wiring.

1.4 Cable Trays

1.4.1 This section of the design standard includes requirements for telecommunications cable tray installation.

1.5 Full Short Circuit Device, Coordination and Arc Fault Study

1.5.1 This section of the design standard includes requirements for a full short circuit, device coordination and arc fault study (The Study) to be performed on the complete electrical system. The Study shall be performed utilizing the current ANSI/IEEE standards.

1.6 Enclosed Switches

1.6.1 This section includes enclosed switches for use as disconnects in service and distribution systems rated 600 volts and less.

PART 2: PRODUCTS

2.1 Underground Ducts and Manholes

2.1.1 Ducts:

2.1.1.1 Must be UL listed

2.1.1.2 All ducts shall be Schedule 80 Rigid Nonmetallic Conduit or Schedule 80 Rigid Nonmetallic Utility Conduit with integral bell ends.

2.1.1.3 Electrical and Telecommunications ducts shall be 6" diameter standard.

2.1.2 Concrete:

2.1.2.1 Electrical designer shall be responsible for coordinating minimum concrete standards with the project civil engineer. The minimum requirements are:

2.1.2.1.1 ⅜" minimum aggregate

2.1.2.1.2 Slump: 4½" – 5"

2.1.2.1.3 Strength: 3000 psi, in accordance to ASTM 039-44

2.1.2.1.4 Electrical concrete envelope shall contain red dye at 8 lbs. per cubic yard of concrete.

2.1.3 Manholes

2.1.3.1 The manhole shall have grade 60 reinforcement of H20 loading and 4500 psi concrete. Pre-cast terminators shall be provided at each penetration shown on the drawings.

2.2 Building Wire and Cable

2.2.1 All conductors shall be soft drawn annealed copper, ninety-eight (98%) conductivity, continuous, from outlet to outlet.

2.2.2 Minimum size of wire shall be #12 AWG. (Exception: Control wire may be #18 AWG.)

2.2.3 Conductors #8 AWG and larger shall be stranded. D. Conductors #10 AWG and smaller shall be solid.

2.2.4 All wire insulation for 600 volt conductors shall be type THHN-2, THHN, or THWN.

2.2.5 Non-metallic sheathed cable is strictly prohibited.

2.3 Raceways and Boxes

2.3.1 All electrical raceway design shall conform to the minimum requirements of the latest edition of the National Electric Code (NEC).

2.3.2 All floor boxes used at the University in new construction shall be cast in-place. No poke-thrus are allowed in new construction.

2.3.3 Building renovations may use UL approved fire rated poke-thrus on approval of the University.

2.4 Cable Trays

2.4.1 Cable tray shall be aluminum minimum12" wide ladder bottom supported from both sides sized to support the cabling load.

2.4.2 Solid bottom cable tray is permissible in the event that the working clearances as described below cannot be met, or the ceiling space is non-accessible.

2.5 Full Short Circuit Device, Coordination and Arc Fault Study

2.5.1 Acceptable software packages are ETAP and SKM Power tools.

2.5.2 If the A/E makes self-generated calculations a copy of all the calculations shall be included.

2.5.3 Submit three (3) copies of the complete short circuit, a copy of the as-build version, device coordination and arc Fault Study. The study shall include a one-line diagram showing all pertinent equipment data and identify all buses, a list of fault levels at each bus for three-phase bolted faults and ground faults, equipment data including circuit sizes and lengths, equipment interrupting ratings, time-current plots graphically illustrating protective device settings.

2.5.4 Short circuit submittals are required prior to the purchase of any equipment so that the required interrupting current ratings and duties can be substantiated.

2.5.5 Final device coordination and arc fault study submittal required prior to energizing equipment. Equipment labels shall be provided for arc fault study.

2.6 Enclosed Switches

2.6.1 Use heavy duty enclosed switches only.

PART 3: EXECUTION

3.1 Underground Ducts and Manholes

3.1.1 The bank of ducts shall be installed by the built up method. A/E shall require 3” base and intermediate Snap-Loc spacers installed 3” above the bottom of the trench and spaced throughout the duct bank at 6’ on center. The concrete envelope shall be reinforced with #4 rebar along the continuous length of the ducts and #4 stirrups located at 4’ intervals. Ducts and reinforcing shall be anchored into grade prior to concrete placement to prevent duct floating.

3.1.2 Grounding: Duct banks containing power conductors shall have one (1) #4/0 bare copper ground located in the lower portion of the duct bank. The ground conductor shall extend 4’ into buildings and manholes.

3.1.3 A/E shall require factory bends and sweeps of 36” minimum radius and/or combination of 5° couplings.

3.1.4 Provide 25% spare electrical conduits and 50% spare telecommunications conduits. Minimum size duct bank shall be 6 conduits.

3.1.5 Manhole Grounding and Design

3.1.5.1 Grounding System:

3.1.5.1.1 Duct bank grounding conductor shall penetrate wall of manhole on all applicable sides and extend 4’ inside the manhole.

3.1.5.1.2 A looping grounding system consisting of #4/0 bare copper wire shall completely encircle each manhole and shall be thermo-welded at all connections including the duct bank grounding conductor penetrating the manhole. Use of ground rods is not accepted.

3.1.5.1.3 Ground conductor in duct bank shall be connected to transformer case and building grounding system.

3.1.6 Drawing Requirements:

3.1.6.1 Duct bank detail design shall be coordinated through the civil engineer and civil drawings. As a minimum, the electrical engineer shall provide a site plan depicting the quantity of ducts and the general routing of the ducts through the campus infrastructure and plan profiles indicating the quantity and intended conduit layout in the duct bank. The electrical engineer shall locate new manholes, and existing manholes and ducts where applicable to coordination. New manholes shall be indicated and labeled. The site plan shall indicate existing utilities (other than electrical and telecommunications) and locations and coordinate conflicts.

3.1.6.2 The A/E shall provide duct bank details to depict electrical requirements including grounding and minimum cover.

3.1.6.3 The A/E shall provide duct bank sections indicating conduit layout in the duct bank. A plan and profile drawing shall be required for each layout of ducts.

3.1.6.4 The A/E shall provide manhole details to depict proper grounding practices and typical ring and cover placement.

3.1.6.5 The A/E shall provide details for building penetrations and terminations for each building affected by the design.

3.2 Building Wire and Cable

3.2.1 Welds, splices and joints shall not be permitted under any circumstance.

3.2.2 All branch circuit homeruns shall contain no more than two multi-wire branch circuits. Dedicated neutral circuits shall be used where the load generates harmonics (e.g.: computers).

3.2.3 Homeruns shall be clearly indicated on the floor plans.

3.2.4 MC cables are acceptable for light fixtures within a room. Light fixtures and devices must be wired so that downstream devices are not disabled by removal of any upstream device.

3.3 Raceways and Boxes

3.3.1 In addition to the minimum NEC requirements all raceway design shall conform to the following guidelines:

3.3.1.1 Installed conduit shall be Rigid Galvanized Conduit (RGC) or Intermediate Conduit (IMC). Electric Metallic Tubing is permissible only in sizes of ¾” to 2½”.

3.3.1.2 In exposed exterior areas, use only RGC for conduit less than 2”. For conduit 2” or more use rigid aluminum.

3.3.1.3 Wet or corrosive areas use SCH 80 PVC raceway.

3.3.1.4 Liquid tight flexible conduit installed in sizes ¾” and larger shall not exceed 6’ in length.

3.3.1.5 Flexible metal conduit is permissible in sizes ¾” and larger with one exception. Applications with fixture tails may be ⅜”.

3.3.1.6 Surface metal raceway:

3.3.1.6.1 Classrooms/Offices: extruded aluminum with brushed natural finish.

3.3.1.6.2 Laboratories: enamel coated IMC; stainless; aluminum. [Requires specific approval of the Owner.]

3.3.1.7 Liquid tight flexible conduit or EMT shall be used under raised computer floors in the length and size necessary to serve the load. The conduit must originate and terminate in the same room. Do not use rubber cord for this application.

3.3.1.8 All direct buried conduit shall be SCH 80 PVC with a minimum diameter of 1”. In addition the PVC shall transition a minimum of 18” below grade before the surface stub-up occurs.

3.3.1.9 All floor boxes shall be shown on floor plans and clearly denoted as such by symbology.

3.3.1.10 Drawing shall clearly indicate electrical and telecommunications conduit, with sizes, serving the floor box.

3.3.2 Conduit shall not be mounted in or on the floor. All drops shall be made from the ceiling.

3.3.3 All electrical box design shall conform to the minimum requirements of the latest edition of the NEC and be approved for area conditions.

3.3.4 Telecommunications Requirements

3.3.4.1 All telecommunications outlet locations shall have a 4” x minimum 2 ⅛” deep recessed box with a single gang or double gang device ring with a 1” conduit extended to the accessible ceiling space. The conduit should extend a minimum of 8" above the insulation batts and with a minimum of 12" of working clearance above the open end, where possible. A pull string should also be provided. Follow the material standards for various locations as indicated above in the electrical design requirements.

3.3.4.2 All telecommunications device locations shall be indicated on special systems plans and telecommunications floor plans. It is the responsibility of the electrical designer to coordinate locations with telecommunications consultant.

3.4 Cable Trays

3.4.1 Location: Cable tray must be designed to route through the corridors of the building. Designer shall coordinate ceiling elevation requirements through architect and other trades. Cable tray shall be run above water piping. Designer shall provide a 12” vertical working clearance above the cable tray with no continuous obstructions. In addition, a 12” space must be provided on either side for working access.

3.4.2 A/E is responsible for coordinating the installation of the cable tray with the Telecommunications Designer. Drawings should clearly indicate that electrical contractor is responsible for cable tray installations.

3.4.3 A/E shall show all routing of cable tray on the special systems floor plans and coordinated with the telecommunications floor plans. Floor plans shall indicate firewall penetrations.

3.4.4 Fire stopping: Penetrations in fire rated walls shall be made to the size of the cable tray and filled with fire pillows.

3.4.5 Grounding: All cable trays shall be grounded per the latest requirements of the NEC, EIA/TIA standards.

3.4.6 Attachments: No medium voltage boxes or conduit shall be physically attached to the cable tray.

3.4.7 Indicate mounting height and transition locations on the floor plans.

3.4.8 Changes in horizontal and vertical directions shall be made with manufactured cable tray offsets.

3.4.9 A/E shall coordinate violations of working space with the University prior to final design of cable tray.

3.5 Full Short Circuit Device, Coordination and Arc Fault Study

3.5.1 The study shall be prepared and certified with the registration seal and signature of a Texas Registered Professional Engineer. The Engineer shall be in private practice and should not be employed by the manufacturer of the electrical equipment in order to provide a non-biased third party analysis. The Engineer shall be qualified by experience in the preparation of studies having similar requirements and magnitude.

3.5.2 The initial copy of the study shall be submitted prior to the purchase of any equipment so that the required interrupting current ratings and duties can be substantiated. The Electrical Engineer shall indicate equipment ratings on the electrical drawings that are found in the recommendations of the study.

3.5.3 The Short Circuit Analysis shall terminate at each branch bus at the lowest utilization voltage secondary bus where the symmetrical short circuit RMS amperes are less than 10,000 amperes (10,000 amperes total source plus all motor contribution). It is the intent of these specifications to determine all locations in the entire electrical system where the symmetrical short circuit amperes meets or exceeds 10,000 amperes at either 208 or 480 volts. The short circuit analysis shall compare interrupting ratings of all electrical protective devices connected to each bus with that of the available fault current at the load terminals of each protective device.

3.5.4 The Fault and Device Coordination shall include all of the primary protective device time current plots including the last source side protective device of the electrical service equipment. The primary coordination plots shall be at the ampere scale of the primary voltage and shall include all transformer primary protective devices. The coordination plots shall terminate with each transformer secondary main fuse or breaker and the largest branch fuse or breaker immediately following the secondary main protective device. Where a single secondary main protective device is not installed, the plots shall terminate with the next load side protective device following the first secondary protective device. These secondary breakers or fuses shall be plotted on a secondary voltage ampere scale, and shall include the transformer primary protective device plotted at the same ampere scale as seen at the secondary voltage. The protective device study shall include a separate analysis for phase and ground protection.

3.5.5 The Electrical Contractor shall furnish the Engineer all of the as-built wire sizes, insulation types, conduit types, and circuit length for use and verification in the study.

3.5.6 The as-built version of this study shall be submitted to the Owner for approval a minimum of 30 days prior to final inspection of the electrical system.

3.5.7 Primary loop distribution power shall come from a main 12 kV feeder breaker located in the University Power Plant. Existing data on settings, CT's, feeder sizes and types, etc., shall be obtained from the Owner.

3.5.8 Short Circuit Analysis

The Short Circuit Analysis shall include the following:

3.5.8.1 A schematic one-line drawing of the entire electrical system. Each motor, 10 HP and larger, shall be shown and identified. Each bus shall be assigned an identification number.

3.5.8.2 Source voltage and impedance data shall be given in the analysis, including reactance and resistance in OHMS to the source, and available symmetrical and asymmetrical short circuit amperes at the point of delivery of electrical power. Short circuit amperes shall be based on a bolted three-phase and phase-ground faults.

3.5.8.3 At each bus the following shall be calculated:

3.5.8.3.1 Symmetrical RMS short circuit amperes, calculated using total source and motor contribution reactance and resistance values.

3.5.8.3.2 Asymmetrical average three-phase RMS amperes at ½ cycle, calculated using actual total source and motor contribution X/R ratio.

3.5.8.3.3 Reactance (X) and resistance (R) in OHMS at the voltage of the device being examined, including both Owner's Power Plant source and all motor contributions.

3.5.8.4 Cable sections shall indicate voltage, wire, size, cable length, reactance and resistance of the section in OHMS, and total X & R to the source.

3.5.8.5 Transformer sections shall indicate transformer KVA, secondary voltage, percent impedance, percent reactance, percent resistance, and total X & R value in OHMS at the secondary voltage to source, including Owner's Power Plant source impedance plus any primary motor contribution.

3.5.8.6 Busway and miscellaneous devices shall include all parameters, including operating voltage, section X & R values in OHMS, and total X & R values in OHMS to the source, based on source impedance plus any motor contribution.

3.5.8.7 Bus summary sheets shall be provided giving consecutive bus numbers, description, and voltage, X & R values in OHMS including Owner's Power Plant plus all motor contributions, symmetrical and asymmetrical short circuit amperes, X/R ratio, and asymmetrical factor.

3.5.8.8 Motor summary sheets shall provide motor description and all pertinent motor data including sub-transient reactance for each motor 10 HP and larger.

3.5.9 Protective Device Coordination Study

The Protective Device Coordination Study shall include the following:

3.5.9.1 Time-current coordination plots shall be made on 8½” x 11” log-log sheets and shall graphically indicate the coordination proposed for all of the systems. The plots shall include complete titles, and a legend.

3.5.9.2 The Owner's Power Plant relays, fuses, or protective devices shall be plotted with all load protective devices at the same voltage. Owner’s power plant relays are not subject to change, therefore building system protection and coordination must be “under” power plant settings.

3.5.9.3 The transformer's primary protective device, transformer magnetic inrush, transformer ANSI withstand points, secondary voltage fuse or circuit breaker and largest feeder fuse or circuit breaker shall be plotted at the primary voltage. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current. Fuse curves shall be identified as either total clearing time or damage time as applicable.

3.5.9.4 Low voltage circuit breakers shall have instantaneous, short delay, and long- time pickup ampere values indicated as applicable to the specific circuit breaker. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified.

3.5.9.5 The coordination plots shall include significant motor starting characteristics and large motor protective devices for motors over 10 HP, include VFD.

3.5.9.6 Feeder circuit breakers shall have the time-damage curve of the feeder conductors plotted to indicate protection of the conductor insulation at the total clearing time of the circuit breaker or fuse. This time-damage point shall be calculated for the specific parameters of conductor insulation used.

3.5.9.7 A summary tabulation shall be included in the study listing all adjustable protective devices with all recommended settings and each adjustable band included in each device.

3.5.9.8 High voltage relays shall have coil taps, time-dial settings and pick-up settings identified. Current transformer ratios shall be stated. Relays shall be separated by a time margin to assure proper selectivity where feasible. The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.

3.5.9.9 Similar type plots shall be made for all ground fault conditions and shall indicate any time delay or zone blocking.

3.5.9.10 Ground fault coordination must be coordinated with NEC requirements for service entrance equipment.

3.5.10 Arc flash Study

The Arc Flash Study shall be in accordance with NFPA 70E and IEEE 1584 and include the following:

3.5.10.1 Study shall be based on installed equipment and performed before initial energizing of equipment.

3.5.10.2 Study shall determine incident energy level, minimum approach distance, restricted approach boundary and required level of Personal Protective Equipment (PPE) required for each case as required by Codes and Standards.

3.5.10.3 Engineer shall provide contractor with Arc Flash labels to be placed on equipment.

3.5.10.4 A summary report shall be provided to owner for approval prior to printing Arc Flash labels.

END OF 26 05 00