ELECTRICAL STANDARDS
REVISED APRIL 2023

Contents

ELECTRICAL

A. General

1. All electrical plans shall be approved by Texas Water Company (TWC) or their designated representative prior to commencing construction.
2. All electrical work is subject to inspection by Texas Water Company (TWC) or their designated representative.
3. All electrical work shall be installed in accordance the 2023 NFPA70 National Electrical Code and with TWC standard details (see attachments).
4. Electrical equipment buildings shall be located between distances of 50 feet minimum to 150 feet maximum, from pump motor locations.
5. Engineer to provide complete design drawings and specifications. Drawing package to include site plan, load calculations, one-line diagrams, schematics, panel layouts, grounding design, etc. Include types, sizes, quantities, and routing of all raceways and conductors. Each duct bank section shall be detailed. Provide interior and exterior layout details, schematics, and one-line diagrams for all control panels and motor control centers (MCCs).
6. All equipment shall be designed to automatically reset after power outages.
7. Main electrical service shall be provided with a Transient Voltage Surge Suppressor (TVSS)/Surge Protection Device (SPD) including overcurrent protection on each leg. Eaton surge protection devices (SPD) shall be provided and located at service entrances.
8. Electrical service shall be 480V 3-phase. Phase converters are not allowed. Requests for alternate voltage electrical services shall be reviewed and considered for approval by TWC on a case-by-case basis.
9. Electrical service disconnects shall be enclosed circuit breakers unless otherwise approved by TWC.
10. Enclosure types:
    a. Outdoors: NEMA 3R at all sites
        i. EXCEPTION: Wastewater treatment plants or other corrosive environments shall be furnished with NEMA 4X enclosures where applicable.
    b. Indoors (within pump room): NEMA 4
    c. Indoors (within dedicated electrical/controls room without pumps): NEMA 1
11. Provide electrical rack with roof shelter for electrical and control equipment installed outdoors. Orientation of shelter shall be such that panels face east or north.
12. Provide general use receptacles for temporary loads, power tools, etc. The receptacles shall be located in the electrical room, at the electrical rack, and within 10' from each pump.
13. Provide 20 amp receptacle with dedicated circuits for heat trace and freeze protection. The receptacle shall be mounted inside a 16"x16"x8" or larger NEMA 4 box. At minimum dedicated circuits shall be provided at each of the following locations (where applicable); well, high service or booster pumps, transducer, and chlorine dosing line.
14. Electrical panels shall have tinned copper bus and bolt-on type circuit breakers.
15. All surface mounted device boxes shall be FD type sand cast aluminum with corrosion-resistant 316SS cover screws.
16. All receptacles shall be duplex 120V 20A GFCI-WR. Outdoor locations shall have aluminum while in-use covers.
17. Eaton Mini-Power Centers (MPZ) shall be used at locations where required for 240/208/120V power.
18. Eaton electrical panels and appurtenances shall be used throughout locations unless other manufacturers have been approved by TWC.
19. Provide laminated type written panel circuit directories in all electrical panels. An as-built laminated one-line diagram shall be located in each electrical room.
20. Use aluminum hardware, struts, and straps. If anchors are necessary, corrosion-resistant 316SS anchors shall be used. All exterior mounted electrical enclosures and devices shall be mounted on struts.
21. Lockout/Tagout (LOTO) boards shall be provided in electrical room buildings to provide a hazard abatement tool during maintenance or repair work of equipment.
22. All electrical enclosures shall have black heavy duty plastic labels with white 3/8" block lettering or engraved aluminum labels. Labels shall be attached with aluminum rivets on NEMA 1 panels or for indoor installations only. All instruments shall have round shaped black plastic tags with white 1/4" block lettering

or engraved aluminum tags, attached with corrosion-resistant 316SS cable. Label circuit numbers on all device cover with white adhesive tape type labels with black machine printed 3/16" block lettering. All tags shall be consistent throughout locations. Identification for electrical systems shall be as follows:

a. Panelboards: identify panel name, ampere rating, voltage, phase, power source and circuit number, and primary overcurrent protective device. Provide a typed circuit directory to identify loads served.
b. Transformers: identify kVA rating, voltage, and phase for both primary and secondary, power source and circuit number, and loads served.
c. Enclosed switches, circuit breakers, and motor controllers: identify voltage, phase, power source and circuit number, and loads served.
d. Label each junction/pull box cover plate with the circuit number of the circuits it contains. Label each exiting conduit at the point where it exits the junction box with the circuit number it contains. If the raceway system is in an exposed area label the inside of the junction/ pull box cover plate only.

23. For air conditioning within electrical room buildings, Bard units with dual lead-lag control shall be used. Bard conditioning units shall have the following: low ambient control, filter pressure switch and alarm relays. Bard MC4002-B thermostat shall be used in conjunction with two Bard air conditioning units. Each unit shall be rated to handle design conditions.
24. For smaller electrical room buildings, Freidrich or Frigidaire through-the-wall units may be used with approval from TWC. Mitsubishi mini-split systems may be used with approval from TWC.
25. Provide the ability to operate the facility with one pump removed for maintenance by utilizing a Hand-Off-Auto (HOA) switch and control that alternates remaining pumps in service with no parallel switching. This allows for proper lockout procedures to be followed when performing maintenance.
26. Non-fused disconnect switches, NEMA 3R type, shall be used at pump locations in lieu of emergency stop switches.
27. Non-fused disconnects shall be installed within 20 feet of motors located within pump rooms to meet NEC 430.102(B) requirements for motor disconnects being in the line of site of motor locations.
28. Power studies sealed by a professional engineer shall be performed by Eaton or by designated contractors as approved by TWC.
    a. Perform analysis of electrical power distribution system using software and data from actual installed equipment and components. Hand calculations are not permitted.
    b. Protective device coordination studies: analyze all known alternate power source scenarios and determine suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for personnel, equipment, and conductors.
    c. Arc flash and shock risk assessment: perform incident energy and arc flash boundary calculations using alternate scenarios to determine the worst-case scenarios to determine the worst-case scenario. Apply arc flash warning labels to all equipment components. Labels shall be compliant with ANSI Z535.4 and in accordance with NFPA 70E 130.5(H).
    d. Provide reports to the Engineer of record and the Owner for all analysis/studies performed.
29. Contractor shall perform operational demonstration testing. Contractor shall startup, test, and verify all equipment is operational prior to scheduling TWC to witness demonstration testing. Operator training shall be conducted on a separate day after demonstration testing has been completed. Contractor shall coordinate scheduling with TWC at least two (2) weeks in advance.
30. The contractor shall maintain service to existing systems at all times during construction. Any work involving power outages, bypass pumping, or any other interruption of flow must be performed between 8:00am and 5:00pm excluding weekends and holidays. All necessary temporary power, bypass pumping, temporary plugs, etc., shall be furnished and performed by the contractor. Coordinate and schedule any such activities with TWC at least two (2) weeks in advance.

B. Motor Starters

1. All full voltage starters shall be NEMA sized, minimum size of 1. Half sized starters and IEC starters are not allowed. These starters shall be provided with solid state overload relays.

2. Toshiba and Schneider (Square D) are the allowable manufacturers for Variable Frequency Drives (VFD). The Toshiba VF model VFD, Toshiba AS3 VFD, or the Schneider Altivar Process VFD shall be provided for all motors unless determined otherwise by TWC. VFD manufacturer substitutions are allowed only with written approval from TWC.
    a. All VFDs will require appropriate filtering and shall be supplied with harmonic filters such that the harmonic distortion caused by device is kept within the limits specified in the IEEE Standard 519-1992, Section 10.
    b. VFD cables shall be required where recommended by manufacturer.
        i. Where VFD cables are required, Belden cables shall be used unless otherwise approved by TWC or Engineer of Record (EoR).
3. If reduced voltage solid state (RVSS) soft starters are to be used at locations, Benshaw or Schneider/SQD shall be used.
4. If motors have across the line starters, Siemens or Eaton contactors shall be used.

C. General Lighting

1. Provide manually controlled, dark sky compliant, LED site lighting in each process area: 15,000 lumens and 4,000K. Provide intermediate hinged aluminum poles in bronze color; anchors and hardware shall be stainless steel. Provide photocells and receptacles at all light poles. Receptacles shall be located on the light pole base and shall be circuited separately from the light circuitry. Switches shall be located on electrical rack or in electrical room. Where applicable, Cooper # GALN-SA2D-740-U-XX-BZ pole light fixtures shall be used on Valmont Structures light pole base.
2. Interior light fixtures throughout sites shall be vapor tight LED fixtures and shall be specified for 4000 lumens and 4000K.
3. Exterior light fixtures installed on equipment buildings shall be weatherproof LED full cutoff wall pack with photocells and motion sensors. Provided lights shall be wall/surface mount above doors, 4000K and 24W minimum. Cooper # IST-SA1X-740-U-XX-BZ wall pack light fixtures shall be used where applicable.
4. Provide 90-minute emergency battery backup for all interior and exterior egress fixtures throughout site.

D. Obstruction Lighting

1. Elevated storage tanks and other structures 150 feet tall and less shall be furnished with an L810 double obstruction light. Both light engines on the obstruction light shall operate simultaneously. RTO-CR27-002 LED L-810 120-240VAC Double Obstruction Light with Infrared unless otherwise approved by TWC.
2. Elevated storage tanks and other structures between 150 feet to 350 feet shall be furnished with an L810 double obstruction light configured to flash in conjunction with an L864 beacon light at a rate of 30fpm with a tolerance of $\pm$ 3 fpm.
3. Elevated structures above 350 feet have additional FAA requirements. Refer to FAA AC 70/7490 Obstruction Marking and Lighting for additional lighting standards.
4. All obstruction lighting shall be controlled by means of photocell or timer according to FAA AC 70/7490 chapter 5.3.

E. Conduit

1. All exposed/above ground conduit shall be rigid aluminum (3/4" minimum) only. Stub-ups from underground to 6" above grade including the 90-degree bends shall be PVC coated aluminum conduit or shall be aluminum conduit wrapped in corrosion tape. No steel galvanized rigid, EMT, or IMC conduit shall be used.
2. Underground conduit shall be Sch 40 PVC (1" minimum) and shall be installed with red tape and backfilled with sand. Underground conduit from the electrical service and any conduit runs with 480V conductors shall be encased in reinforced concrete.
3. For flexible conduit, use Type LFNC flexible seal tight conduit for 3/4" minimum to 2" sizes (1/2" LFNC flex will be allowed for instruments with 1/2" threaded hub entries, all other flex shall be 3/4" or larger). Use aluminum core liquid tight flexible metal conduit for sizes 2-1/2" and larger. Maximum length of flex conduit shall be 24". All connectors shall be aluminum. No smurf tube permitted.

4. All conduit fittings shall be Form 7 sand cast aluminum with aluminum covers and corrosion-resistant 316SS screws. Snap-on covers are not permitted.
5. Use aluminum Myers hubs, grounding type, with insulated throats for all exterior enclosure entries or wet locations.
6. Use UNY and UNF aluminum unions. Galvanized unions are not permitted.
7. Use aluminum seal-off fittings where required by NEC, seal with 3M-2123 re-enterable sealing compound.
8. Use Noalox or other comparable anti-oxidizing agent on all conduit threads.
9. Field bending of conduit shall be accomplished using the appropriate tools. Flame bending is not allowed.

F. Grounding

1. Engineer to design site grounding system to include fencing, electrical rack, generator, RTU, antenna, etc. Resistance to ground for site grounding shall be 5 Ohms or less. Testing report shall be provided at project close out.
2. All grounding electrode conductors and bonding jumpers shall not have any bends greater than 90 degrees.
3. All grounding connections shall be exothermic welded connections unless otherwise stated on EOR plan.
4. A grounding test well shall be installed on the main grounding electrode. The main ground rod shall be installed with a short conductor extension (pigtail) from the ground loop so that the injected test signal will be forced down the ground rod. Refer to Ground Test Well detail.
5. A separate grounding conductor is required for every raceway, including electrical and I&C. Minimum size is 10 AWG.
6. All underground water pipes in contact with earth for 10 feet or more shall be grounded in accordance with NEC 250.52A1. Minimum size is 10 AWG.
7. A grounding ring shall be used throughout all TWC sites in accordance with NEC 250.4.
8. All motor tails shall be grounded by grounding rings. All motor tails shall be grounded to grid for lightning protection.
9. Megger test load and line conductors of all power circuits and submit test reports.

G. Lightning Protection

1. Lightning protection systems shall be installed in accordance with NFPA 780, UL96A, and LPI 175.
2. Complete design drawings shall be prepared by a Lightning Protection Contractor that employs LPI certified Master Installer Designers showing the type, size, and locations of all grounding, down conductors, through roof/through wall assemblies, roof conductors, and air terminals shall be submitted to the engineer for approval.
3. The lightning protection system shall conform to the requirements and standards for lightning protection systems of the LPI, UL, and NFPA. Upon completion, a certification letter and warranty by the installing contractor, i.e: Bonded Lightning Protection Systems, Ltd. shall be delivered to the owner. The certification letter and warranty ensure the system has been installed by a contractor who employs LPI certified Master Installer Designers, and the building structure is protected by a lightning protection system meeting current standards.
4. Upon completion of the installation, the Lightning Protection Contractor shall provide a LPI Master Installation Certification, LPI Re-conditioned Certification or LPI Limited Scope Report from the Lightning Protection Institute – Inspection Program (LPI-IP), depending on the lightning protection scope of work.
5. The Lightning Protection Contractor shall have a minimum of 10 years lightning protection installation experience, be a member of the LPI and employ LPI certified Master Installer Designers.
6. Lightning protection components shall be UL listed and labeled.
7. Lightning protection system ground rods shall be copper-clad steel, 5/8 inch in diameter and 10 feet in length. Lightning protection system electrodes must be bonded to all other grounding system electrodes as required by the NEC article 250 and NFPA 780.
8. If a ground counterpoise is required, it shall be a minimum of the main size lightning protection conductor.
9. At least one test well shall be provided for testing purposes.

10. For structures exceeding 200 feet in height, an intermediate loop (potential equalization) shall be addressed as outlined by LPI, UL, and NFPA standards.
11. For structures exceeding 60 feet in height, a ground counterpoise shall be addressed as outlined by LPI and NFPA standards.
12. A surge protection device at the main electrical service entrance is required by lightning protection standards. The surge protection device must comply with the most current version of UL Standard 1449 as a Type 1 or Type 2 lightning rated unit of 20kA or more. It shall be the responsibility of the Electrical Contractor to furnish and install or verify that such surge protection device is installed on the main electrical service.
13. Lightning protection system and grounding system must be closely coordinated to maintain equipotential impedance throughout the systems.
14. All lightning protection system connections shall be exothermically welded connections.
15. All lightning protection systems conductors and bonding jumpers shall not have any bends greater than 90 degrees.
16. At a minimum, lightning protection shall be provided for:
    a. Motors.
    b. Ground storage tanks.
    c. Elevated storage tanks.
    d. Pump/solenoid shade structures.
    e. Control buildings.
    f. Chlorine rooms.

H. Conductors

1. All MCC control wiring shall be UL-508 compliant, flexible 41 strand tinned copper, size 14 AWG minimum, 600V insulation, Type MTW for MCCs.
2. All other conductors shall be stranded copper THHN / THWN-2.
3. Phase colored insulation is required for all conductors.
4. A separate neutral conductor is required for every 120VAC or 277VAC circuit.
5. Coordinate sizes of components to accommodate voltage drop. Coordinate direct buried cable with other trades to mitigate conflicts. Coordinate with equipment installed by other trades to provide suitable terminations for equipment installed by others.
6. Color code conductors using integrally colored insulation. Use the following conventions (listed in phase A, B, C, Neutral order). Maintain consistent color coding throughout the project:
    a. 480Y/277 V, 3-Phase: brown, purple, yellow, gray.
    b. 208Y/120 V, 3-Phase: black, red, blue, white.
    c. 240/120 V, 3-Phase High Leg Delta: black, orange, blue, white.
    d. 120/240 V, 1-Phase: black, red, white.
    e. Grounding in all systems shall be green.
7. Label wiring with yellow heat shrink type markers with black machine printing. Cloth wire wrap shall be permitted in the field.

INSTRUMENTATION AND CONTROLS

A. General

1. All sites shall have a SCADA system appropriate for the applicable service area. Panels shall be provided by The Dudley Company (Hierholzer Engineering Inc.) based in Marion, TX.
2. Coordinate with Hierholzer Engineering Inc. staff to determine service area, site specific requirements, and appropriate radio. SCADA system shall be designed and installed in accordance with TWC standards. All SCADA points inside the pump control panel shall be landed on terminal strips mounted on the backplane.
3. Provide a Power Quality Meter (PQM) in its own separate enclosure on load side of service or on load side of main disconnect. A PQM shall be used at locations with 400A services or larger. The PQM shall be EATON POWER XPERT METER 6000, or similar, with outputs as required to provide amperage readings of all three phases to the applicable control room(s) via SCADA.

4. All equipment shall be designed to automatically reset after power outages.
5. All panels shall be tested in accordance with NFPA 70.
6. Provide LED strip lighting with door switch inside control panels if the enclosure size is greater than or equal to 30" wide and greater than or equal to 12" deep.
7. For packaged systems, pump controllers shall be provided by the pump manufacturer. Provide an OIT touch screen for local system monitoring and adjustment of setpoints. Mount the OIT on the exterior door of the pump control panel with a hinged UV protective cover, if exterior, by Shade Aide or TWC approved equal. Furnish a spare pump controller, backup programming CD, and one spare I/O module of each type.
8. All PLCs shall be of the same communication type as established by Hierholtzer Engineering Inc. (HEITX); each with 10% minimum spare I/O, all mapped to the top end. This applies to the entire site and all equipment.
9. At a minimum, the following points shall be monitored in the control room(s):
    a. Pump run status for each pump.
    b. Pump auto status for each pump.
    c. Common pump fault for each pump (seal fail, over temp, fail to start, motor overload).
    d. Generator runs.
    e. Generator fault.
    f. Generator low fuel alarm.
    g. Power fail.
    h. ATS position.
    i. High float.
    j. Low float.
    k. System in backup.
    l. PQM ampacities.
    m. Transmitter(s) level.
    n. Communications fail.
10. RTU backup power supply shall be a 24V battery system with trickle charger. The battery system shall have sufficient capacity to power the RTU for a minimum duration of four (4) hours.
11. All control panels shall not be penetrated through the top of panels.
12. Provide AC for control panel cabinets. Fans and louvers are acceptable for panels located within dedicated electrical rooms.
13. All enclosures shall be at least NEMA 3R rated with external mounting lugs and lockable 3-point latch system. Mount all enclosures on aluminum struts.
14. All control panel wiring shall be flexible 41 strand tinned copper, size 14 AWG minimum, 600V insulation, Type THHN for control panels. Per section 66.9.1 of the UL508A, the following color coding shall be implemented through the panel:
    a. Black – all ungrounded control circuit conductors operating at the supply voltage.
    b. Red – ungrounded AC control circuits operating at a voltage less than the supply voltage.
    c. Blue – ungrounded DC controls circuits.
    d. Yellow or orange – ungrounded control circuits or other wiring.
    e. White or gray or three white stripes on other than green, blue, orange, or yellow – grounded AC current-carrying control circuit conductor regardless of voltage.
    f. White with blue stripe – grounded DC current-carrying control circuit conductor.
    g. White with yellow stripe or whit with orange stripe – grounded ac control circuit current-carrying conductor that remains energized when main disconnect switch is in the "off" position.
15. All 4-20mA signal wire shall be 18 AWG twisted shielded.

EMERGENCY GENERATOR AND TRANSFER SWITCH

A. General

1. Provide a permanent emergency generator and an automatic transfer switch (ATS) at each necessary location. If a permanent generator is not required by TWC, provide a NEMA 3R manual transfer switch located outside and 4/0 camlocks for a portable generator to be connected. All site requirements shall be confirmed with TWC.

2. Provide ASCO, PSI, or Zenith transfer switch, automatic (ATS) or manual (MTS) with programmable exerciser (with and without load), mounted on vertical strut or housekeeping pad, external mounting lugs, and lockable 3-point latch system. Substitutions are not allowed.
    a. All ATS's shall be delayed transition type.
    b. ATS Hand/Off/Auto Switch: Provide HOA switch that allows the ATS to switch to source 2 (emergency power) via "hand" position and operate facility under generator power. The switch shall remain in "hand" until the user manually selects a different position. The intent of the HOA is to allow the user to test the generator under facility load or manually engage the generator if desired, without having to operate the normal power circuit breaker feeding the ATS.
3. Enclosure types:
    a. Outdoors: NEMA 3R, unless otherwise approved by TWC
    b. Indoors (within pump room): NEMA 4
    c. Indoors (within dedicated electrical/controls room): NEMA 1
4. Generator shall be manufactured by Caterpillar, Cummins, or Kohler; substitutions are not allowed unless approved.
5. Size generator to operate the facility at 100% capacity with 20% maximum voltage drop and 10% frequency dip for any motor starting conditions. Max loading 90% of rated capacity.
6. For permanent or portable generators, provide diesel or propane powered generator. Fuel capacity shall be 24 hours minimum at 100% generator load rating. Maximum storage for fuel calculations shall be 90% of tank capacity.
7. Level of sound shall be 60 to 80 d(B)A measured at full load at 7 meters with provided sound attenuation enclosure.
8. Generator shall have a battery charger and dry contacts for all alarms.
9. Generator and ATS alarms shall be monitored via Modbus to SCADA.
10. Generators shall be equipped with a low fuel alarm.
11. Generator shall be mounted on a cast-in-place reinforced concrete pad with perimeter beam. Concrete pad shall allow for a 3-foot working clearance (minimum) around entire generator.

B. Testing

1. All testing shall be performed by the contractor and witnessed by TWC.
    a. Contractor shall perform operational demonstration testing.
    b. Contractor shall startup, test, and verify all equipment is operational prior to scheduling TWC to witness demonstration testing.
    c. Operator training shall be conducted on a separate day after demonstration testing. Contractor shall coordinate schedule with TWC at least two (2) weeks in advance.
    d. Demonstration testing shall include HOA and generator testing from supply 1 to supply 2 for a minimum duration of 30 minutes and then back to supply 1.
    e. Test equipment must be calibrated annually.
2. Perform onsite load bank testing as follows:
    a. Perform cold start block test at 100% load.
    b. Perform 4-hour load bank testing, 2-hours of which shall be at 100% load.
    c. Perform 1.5-hours facility load testing.
    d. Refill fuel tank to 90% capacity upon completion of testing.