CHAPTER 7 ELECTRICAL REQUIREMENTS

7.01 General

A. The electrical systems shall comply with the currently-adopted version of National Electric Code (NEC). The electrical equipment shall be manufactured in accordance with the following standards:

1. Institute of Electrical and Electronic Engineers (IEEE)
2. National Electrical Manufacturers Association (NEMA)

B. All electrical equipment shall be “labeled” indicating compliance with the standards of a nationally recognized testing organization, i.e., Underwriters Laboratory (UL), Factory Mutual System (FM), or Canadian Standards Association (CSA). Provide arcflash labeling where appropriate per NFPA 70.

C. All power distribution equipment and electrical panels shall be ‘dead front’ such that personnel are not exposed to energized terminal blocks, wiring when accessing resets or switches.

D. Explosive atmospheres: All electrical equipment, raceways, and enclosures located in explosive atmospheres per NFPA 820 and Chapter 5 of NEC shall be suitable for Class I, Division I or Class I, Division 2.

E. The electrical design may include one or more of the following:

1. Service entrance sections
2. Switchgear sections
3. Motor control sections
4. Standby and/or dual-power systems
5. Conduit and wiring.

F. Main Disconnect: When the main and/or service disconnect is located within the building or dedicated electrical room, a fire department-approved KNOX box shall be installed on the exterior of the building, entrance gate, or adjacent to the electrical room door as approved by the COS Fire Department.
G. All equipment shall be supported and restrained per structural requirements.

H. Each design shall include power demand information that will be needed in order for Contractor to apply for electrical service from the Arizona Public Service Company. The design shall be provided with short-circuit protection.

I. The Engineer shall coordinate with the City to initiate contact with Arizona Public Service Company for:
   1. Projects requiring new utility power supply
   2. Expansion of existing utility power that will affect Arizona Public Service Company
   3. Obtaining design drawings from Arizona Public Service Company.

J. The Engineer shall be responsible for obtaining federal, state, and local permits for the project in accordance with Chapter 1, which includes but is not limited to the following:
   1. Building permits for electrical buildings and facilities
   2. Air permits for all generators.

K. The electrical design shall include transient voltage surge suppressors at distribution points for protection of electrical and instrumentation equipment.

L. The design of all electrical facilities shall be completed by a registered electrical Professional Engineer in the State of Arizona.

M. The design shall incorporate provisions necessary for future expansion, which includes but is not limited to future equipment, future instrumentation, future security system, future alarm systems, electrical power for both current and future equipment, spare power conduit, spare control conduit, and space for future electrical equipment.

N. If equipment has handswitches for remote control, the handswitch positions shall be labeled “Hand-Off-Auto”. No other naming convention will be accepted.
7.02 Electrical Room Architectural Requirements

A. General: Electrical rooms shall be designed with sufficient space for equipment access and removal in accordance with NEC and with sufficient egress per the adopted codes and regulations.

B. Walls: Electrical room walls shall be concrete masonry block construction and rated as 4-hour fire walls.

C. Housekeeping pads: All electrical equipment shall be installed in reinforced concrete housekeeping pads.

D. Signage shall be provided to clearly identify electrical disconnects as well as all electrical panels with rated voltage, amps, lockout-tagout requirements, and any other appropriate warnings.

E. Doors: Doors shall be required as follows:

1. A minimum of one set of double doors is required with direct outdoor access for rooms where MCCs and other panels that exceed 3-ft. width are installed.

2. A minimum of one 3-wide door to building exterior shall be provided.

3. Provide double doors with a removable transom to allow for removal of large equipment such as MCCs.

7.03 Electrical Room HVAC Requirements

A. General: Provide HVAC systems for all electrical rooms, occupied spaces, and mechanical rooms, which meet requirements of Chapter 9.

B. Electrical rooms and spaces shall be conditioned with air conditioning to maintain suitable temperature and low humidity. Evaporative cooling of electrical rooms and spaces is not allowed.

C. Spaces that house electrical equipment shall be air-conditioned. Examples of equipment include but are not limited to the following:

1. Motor Control Centers (MCCs) where VFDs or soft-starts are housed

2. Programmable Logic Controller (PLC) panels

3. Uninterruptible Power Supply panels and PLC panels shall be housed in an air-conditioned space.

4. Variable Frequency Drives

7.04 Electrical Power System Study

A. The Engineer shall prepare an Electrical Power System Study using ETAP Power Station software or equivalent for all projects, which shall include the following:

1. Background section to describe existing conditions and proposed loads, which addresses future expansion

2. Single line diagrams that illustrate existing and proposed loads, which addresses future expansion

3. Electrical Short-Circuit Analysis of proposed facilities, which addresses future expansion

4. Load Flow Analysis with load summary

5. Arc-Flash Analysis

6. Harmonic Analysis

7. Recommendations and conclusions

8. The results shall be summarized in a written report that is signed and sealed by an electrical engineer registered in the State of Arizona.

B. The Engineer shall include a requirement in the contract documents for the Contractor to update the existing Electrical Power System Study developed by the Engineer with actual installed equipment information using ETAP Power Station software or equivalent for all projects, which includes the following:

1. Background section to describe existing conditions and proposed loads, which addresses future expansion

2. Single line diagrams that illustrate existing and proposed loads, which addresses future expansion

3. Electrical Short-Circuit Analysis of proposed facilities, which addresses future expansion

4. Load Flow Analysis with load summary

5. Arc-Flash Analysis

6. Harmonic Analysis
7. Protective Coordination Study

8. Recommendations and conclusions

9. The results shall be summarized and submitted for review by the Engineer of record before inclusion as part of the operation and maintenance manuals.

10. Contractor shall be responsible for updating the protective devices settings in field based on the recommendations of the report.

7.05 Electrical Equipment, Conduit, and Conductor Sizing and Rating

A. Electrical equipment shall be sized to continuously carry all electrical loads, both current and future, without overloading in accordance with NEC. Equipment and materials shall be rated to withstand and/or interrupt the available fault current.

B. Electrical conduits shall be sized to carry all electrical loads, both current and future without overloading in accordance with NEC.

C. Electrical power conduits shall be sized to contain appropriate size and number of conductors for ultimate design conditions.

D. Encased and embedded conduits: For conduits installed in concrete or under base slabs, etc., the Engineer shall provide and stub-up at all major equipment and panels. The minimum size of buried conduit and embedded concrete is 1 inch.

E. Exposed conduits: The minimum size of exposed conduits is 3/4 inch.

F. Spare conduits: At least one spare conduit for every five placed with a minimum of one spare. The minimum size of spare conduits shall be larger of 1-inch diameter or the largest size conduit used, whichever is largest.

7.06 Grounding and Bonding

A. General: The electrical design shall include appropriate grounding based on the NEC.

B. Ground rods shall be copper-clad steel conforming to UL 467, 3/4 inch in diameter by 10 feet in length of earth contact.

C. Connections above grade shall be made with bolted solderless connectors, and those below grade shall be made by a fusion-welding process.

D. Grounding electrode conductor, service entrance ground wires shall be sized in accordance with NEC.
E. Equipment grounding conductors shall be sized in accordance with NEC. Ground wires shall be protected by conduit, where such wires run exposed above grade or are run through concrete construction.

F. Equipment frames of motor housings, metallic tanks, metallic equipment enclosures, metal splicing boxes, chain-link fencing, handrails, and other metallic noncurrent-carrying metal items shall be grounded. Connections to earth shall be made in the same manner as required for system grounding.

G. Surge arresters shall be grounded. Resistance to ground for intermediate-class arresters shall be not more than 10 ohms and for distribution-class arresters shall be not more than 25 ohms. Ground wire connections shall be not less than No. 4 AWG for distribution arresters and No. 1/0 AWG for intermediate arresters.

H. Lighting poles base shall be connected to an adjacent ground rod.

I. Metallic structures and buildings shall be grounded per NEC.

J. Grounding rings shall be installed using bare copper cable with ground rods at least 25-feet intervals using thermoweld connecting means in accordance with NEC requirements.

K. Duct banks shall contain a concrete-encased system bare copper ground conductor. The system ground conductors shall run continuously in duct banks, through handholes, and other raceway boxes and shall:
   1. Be connected to the structure grounding systems to provide a continuous grounding system
   2. Be bonded to each metallic raceway, panel, switchboard, and other metallic devices associated with the electrical and control systems.

7.07 Electrical Identification

A. Conduit markers based on manufacturer’s standard pre-printed, flexible or semi-rigid, permanent, plastic-sheet conduit markers. Exterior installation shall be meet weatherproof requirements.

B. Cable and conductor wire markers shall be self-laminating vinyl on white background, printed using a printer. Handwritten wire markers are not acceptable. See preferred vendor equipment list.

C. Engineer shall provide a cable/conductor identification schedule in the design drawings, which shall include but not be limited to cable/conductor identification, including voltage, phase and feeder number on each
cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present. Match identification with marking system used in panelboards, shop drawings, specifications, and similar previously established identification for project’s electrical work.

D. Circuit Identification:

1. The 3-phase wires shall be identified at the switchgear, panelboards, and MCCs as Phases A, B, and C.

2. In addition to color-coding, each conductor shall be identified in panelboard, cable tray, or termination with circuit identification labels. This identification is applicable to all power, control, alarm, and instrumentation conductors. Markers shall be slip on PVC sleeve type. See preferred vendor equipment list.

3. Labels for other cabling shall be label number B-292 vinyl. See preferred vendor equipment list.

4. Exposed medium voltage conduits shall be labeled at 50-foot intervals with 1-inch letters stating the voltage - example - “12,470 volts.” Labels shall be vinyl plastic. See preferred vendor equipment list.

E. Provide Arc Flash stickers on all equipment and panels based on arc flash analysis per 7.04 with Personnel Protection Equipment (PEE) requirements.

7.08 Wires and Cables

A. 600 Volt Class Cable Conductor:

1. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction. No. 2 AWG and smaller shall be factory color-coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape. Conductors sized No. 1 and larger shall be Type 2, rated for 90 degrees C. All circuit conductors, No. 6 or smaller shall be “THWN” stranded copper. All other conductors shall be “XHHW-2” stranded copper.

2. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600 volts. No wire external to panels and MCCs shall be less than No. 12 AWG. Panel control wiring shall not be less than No. 14 AWG.
3. Power conductors for lighting and receptacles only may utilize “THWN” solid conductors.

4. Power conductors shall be manufactured by preferred vendor. See preferred vendor equipment list.

B. Instrumentation Cable:

1. Instrument cable shall be Type TC and shall be insulated for not less than 600 volts. Conductor size shall be No. 16 AWG minimum. Twisted shielded, grounded instrumentation cable shall be used for all analog signals.

2. Cable Identification: All conductors shall be numbered with “tube sleeve” type tags with heat impressed letters and numbers.

3. Instrumentation conductors shall be manufactured by preferred vendor. See preferred vendor equipment list.

7.09 Electrical Conduit

A. Raceways:

1. Exposed conduit in an unclassified or hazardous area shall be rigid metal conduit (RMC).

2. Conduits in damp and corrosive areas shall be PVC coated RMC.

3. Underground and/or concrete encased conduits shall be PVC, except elbows, which shall be PVC-coated RMC.

4. Underground to aboveground conduit transitions shall be PVC-coated RMC.

5. No aboveground conduits shall not be smaller than 3/4 inch.

6. No underground conduit shall be less than 1 inch.

7. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight. Conduit shall not exceed a maximum of 36 inches in length.

8. All spare conduits shall be installed with a blue nylon pull string and shall be capped or plugged.

9. Brass labels shall be connected at each starting and ending point of the conduit to identify the “to” and “from” locations.
7.10 Standby Power

A. General: Permanent standby power shall be provided as required in individual facility chapters and where it is not feasible or economical for facilities to be provided with redundant utility power. The following requirements apply to all standby power facilities:

1. Sized to operate essential loads. Essential loads are defined as those loads required to meet facility production/treatment requirements in accordance with the facility permit and include (at a minimum) the following:
   a) Mechanical equipment
   b) Instrumentation and controls
   c) Security
   d) Emergency lighting.

2. Equipped with automatic transfer switch that automatically initiates operation of standby generator when utility power is lost and automatically returns facility to utility power when utility power is restored. Automatic transfer switch shall be fed off the main service equipment.

3. Essential loads/equipment will automatically restart if called upon when transfer to emergency or normal power.

4. Designed to continuously operate essential loads from diesel fuel supply for at least 24 hours and in accordance with the COS air permit requirements.

5. Equipped with automatic exercise function and cool down feature that load tests the generator once per week or as recommended by the generator manufacturer and in accordance with the COS air permit requirements.

B. Pumping Facilities: Standby power for pumping facilities shall be designed as follows:

1. Sized to operate all pumps in the facility, current essential loads, and future loads

2. Equipped to not allow simultaneous operation of equipment from utility power and standby power.
C. Fuel Storage Reservoirs: Fuel storage tanks shall be designed as follows:

1. If possible, the fuel storage should be a UL Listed sub-base type structure located under the generator. The storage tank shall be manufactured by the same manufacturer as the generator.

2. Otherwise, the fuel tank should be a UL Listed.

3. All fuel storage facilities and associated fire protection shall be approved by the COS fire marshal.

D. Generators shall be manufactured by preferred vendor. See preferred vendor equipment list.

7.11 Non-Utility, Pad-Mounted Transformers.

A. General: Facilities that require 480-V power shall be equipped with pad-mounted transformers located on the exterior of the building and beneath a shaded structure that matches the architectural elements of the surrounding buildings.

B. Transformer shall include all devices, wiring, fans, and auxiliary equipment necessary for automatic temperature-controlled forced-air cooling to obtain an additional 15 percent capacity on units 750 through 2000 kVA and an additional 25 percent capacity on units 2500 kVA and over.

C. The transformer shall carry its continuous rating with average winding temperature rise by resistance that shall not exceed 65 degrees Celsius temperature rise, based on average ambient of 30 degrees Celsius over 24 hours with a maximum ambient of 40 degrees Celsius, as defined by ANSI, without loss of service life expectancy.

D. The main transformer tank and attached components shall be designed to withstand pressures 25 percent greater than the required operating design value without permanent deformation. Construction shall consist of carbon steel plate reinforced with external sidewall braces. All seams and joints shall be continuously welded.

E. Insulating liquid shall be silicone-insulating liquid, UL or FM listed as a “Less Flammable” transformer insulating liquid. Provide air terminal compartments for connecting to remote equipment on primary and secondary side of transformer.
F. The transformer shall be designed to carry short-time emergency overloads in accordance with ANSI C57.92 and NEMA TR 98 as applicable. Duration and magnitude of designed withstand capability shall be as outlined in ANSI C57.12 and the latest draft of the IEEE Short Circuit Test Code.

G. Transformer features and accessories shall include:

1. De-energized tap changer with cover mounted
2. Externally operated, padlockable handle
3. Combination drain and filter valve, and sampling device
4. Manual gas pressure test connection
5. One-inch filling plug and filter press connection in cover
6. Dial-type top liquid thermometer
7. Magnetic liquid level gauge
8. Provisions for lifting, jacking, and rolling in two directions
9. Copper ground pad
10. Instruction nameplate
11. Pressure vacuum gauge.

H. Windings: All high voltage windings shall be copper.

I. Transformers shall be manufactured by preferred vendor. See preferred vendor equipment list.

7.12 Switchgears (Medium Voltage)

A. General: Switchgears shall be freestanding, self-supporting equipment equipped with interrupter switches and fuses that meet or exceed the latest edition of ANSI/IEEE C37.20.3 Standard for Metal-Enclosed Interrupter Switchgear.

B. The construction of the switchgear enclosure shall be of the universal frame type using die-formed welded and bolted members; panels should be 11-gauge steel bolted in place.

C. Busbars shall be copper, fully insulated, and silver-plated at the joints. A full-length ground bus shall be provided at the bottom of the switchgear enclosure.
D. Grounding shall be provided through a grounding pad and copper-grounding rod.

E. Incoming and outgoing switch or circuit breakers sections shall have ample spaces for medium voltage, 133 percent shielded, jacketed single conductor stress-cone terminations, and lighting arrestors.

F. There shall be a clear indication of switch or circuit breaker position, a high-impact type viewing window for interrupter switches, and status lights for circuit breakers.

G. Medium voltage switchgears shall be manufactured by preferred vendor. See preferred vendor equipment list.

7.13 Switchgears (480 V), Switchboards, and Distribution Panels

A. General: Switchgears, switchboards, and distribution panels shall be freestanding, self-supporting equipment with overcurrent protection devices that meet or exceed the latest edition of ANSI, IEEE, and NEC Standards.

B. Busses shall be copper, fully insulated, and silver-plated at the joints. A full-length ground bus shall be provided at the bottom of the enclosure.

C. Grounding shall be provided through a grounding pad and copper grounding rod.

D. Provide TVSS (Transient Voltage Surge Suppressants) at appropriate equipment.

E. Switchgears, switchboards, and distribution panels shall be manufactured by preferred vendor. See preferred vendor equipment list.

7.14 Variable Frequency Drives (VFDs)

A. The VFD shall consist of 6- or 18-pulse full-wave diode bridge rectifier, a DC bus, a power transfer inverter and line load reactor, and an input single loss relay to trip the drive. 6 pulse shall only be utilized on smaller than 100 HP motors. 6-pulse VFDs shall be equipped with line side filters and load side dv/dt mitigating devices. 18-pulse drives shall only be utilized on 100 HP motors and above.

B. If required harmonic suppression equipment is necessary based on a harmonic analysis study, the equipment shall be provided in conjunction with the VFD. Equipment selection and design, as well as design calculations, will be reviewed by the City on a case-by-case basis.
C. VFD system motors shall have a service factor of 1.20 (or 1.15 and de-rated by 5 percent of nameplate horsepower). Motors shall be specifically designed for operation with selected variable-speed drive for the specific application.

D. Conductors between the VFD and motor to be sized for 150 percent of the full load amps of the motor.

E. Where applicable, VFDs shall be housed in the MCC. Where VFDs cannot be housed in the MCC, a stand-alone enclosure is acceptable.

F. Specifications for VFDs shall address the following:

1. Motor protection relay
2. Power requirement as a function of pumping capacity
3. Allowable supply voltage wave form distortion
4. Allowable supply voltage notch area
5. Minimum and maximum allowable power factor over working speed range
6. Minimum allowable efficiency at full speed and load
7. Required operating ambient temperature range
8. Required diagnostics provisions
9. Control and monitoring signal interface
10. Allowable acoustical noise level
11. Adjustable ramp acceleration/deceleration time
12. Characteristics (available short-circuit current X/R ratio) of power supply including alternate and standby power supplies
13. Allowable speed regulator error
14. Provide VFD recommended spare parts based on manufacturer requirements
15. VFD shall be provided with a communication port capable of communicating with the PLC.

G. VFDs shall be manufactured by preferred vendor. See preferred vendor equipment list.
7.15 Soft Starters

A. Soft starters shall be used with all constant speed pumps with motors 20 hp or larger, provide power factor corrections capacitors with soft start and soft stop motor starters. Starters shall be designed for the pump control algorithm.

B. Soft Starters less than 100 HP shall be equipped with an integral bypass.

C. Soft Starters must have the following features:
   1. Over and under voltage protections
   2. Over and under current protections
   3. Programmable soft start and soft stop features
   4. Phase loss and frequency protection
   5. Other unbalanced or over-limit functions.

D. Soft Starters shall be manufactured by preferred vendor. See preferred vendor equipment list.

7.16 Motor Control Centers

A. All MCCs shall be provided with a solid state monitoring device and with the following as they apply:
   1. Selector switches for Hand, On, Off, Auto, Remote
   2. SCADA and Indicator Lights for On, Off, Fail, Alarm
   3. All equipment lights shall be Light Emitting Diodes (LED) type

B. Main Disconnect: The Engineer shall lay out the facility such that the main disconnect on the MCC is located adjacent to an exterior door or provided in a dedicated electrical room with exterior access. If site requirements or other building requirements prevent this, a service disconnect shall be located just inside an easily accessible exterior door.

C. Additional requirements for MCC units are as follows:
   1. Low-voltage motor control assemblies conforming to the standards for NEMA Class I, Type B assemblies
   2. Each assembly shall consist of vertical, freestanding sections in accordance with industry standards.
3. The door of each unit containing a disconnect device shall be interlocked so the door cannot be opened unless the device is in the “OFF” position. All unit doors shall be swing doors with locks and continuous length hinges. All MCC units shall be rodent proof.

4. All indicator lights mounted on the MCC shall be of the push-to-test type, LED bulbs only.

5. Each wire end, terminal, and terminal connection shall be uniquely identified with a number.

6. Provide Transient Voltage Surge Suppressor (TVSS) surge protection.

7. Provide Arc Flash stickers with Personnel Protection Equipment (PEE) requirements.

8. All lighting transformers and panelboards shall be integral within the MCC. If size of transformer exceeds the manufacturer’s recommendations of integral, an external transformer and panelboard is acceptable.

9. MCC drawings shall identify all circuit numbers.

10. Controls shall be such so that the equipment will restart after loss of control power.

D. Trip Calibration:

1. Motor overload protection shall be selected based on final motor nameplate information. Size Motor Circuit Protectors (MCP) to coordinate with motor starting characteristics and overload protection. Submit the following for each motor to the City:
   a) Equipment project identification number
   b) Nameplate information
   c) Overload device trip range
   d) Overload device setting
   e) MCP trip device rating
   f) MCP trip device setting if different from rated value.

E. MCCs shall be manufactured by preferred vendor. See preferred vendor equipment list.

1. Set trip devices per the coordination study and verify devices are operating within manufacturer’s tolerances. Make changes to settings not complying with requirements furnished by the Engineer in
accordance with the Technical Specifications. Device settings will be furnished for following equipment:

a) Medium voltage system
b) Low voltage switchgear
c) Secondary unit substations.

7.17 Lightning Protection

A. The Engineer shall provide lightning protection for all facilities, which utilize motorized equipment and/or instrumentation.

B. Standards: The lightning protection system will meet the requirements of the following:

1. Lightning Protection Institute (LPI) LPI 175 - Standard of Practice
2. ANSI/NFPA 780 - Lightning Protection Code
3. UL 96 - Lightning Protection Components
4. UL 96A - Installation Requirements for Lightning Protection Systems.

C. Lightning Protection shall be ANSI/NFPA 780; Class I UL 96A and consist of the following at a minimum:

1. Copper Air terminals on roof(s)
2. Bonding of structure where applicable and other metal objects.

D. Conductor Installations:

1. Install the lightning protection roof system(s) grounding and bending conductors exposed on flat roof areas and concealed at ridge roof areas.

2. Install main downleads completely concealed and sleeved.

3. Other than for the purpose of protecting downlead conductors from damage up to 6 inches above grade level, do not use exposed conduits to conceal the downleads on the exterior of outside walls.

4. Use minimum 1-inch PVC conduits to protect lightning system conductors from damage and bond both ends of PVC-coated rigid steel conduit to conductor.
7.18 Electrical Ductbanks

A. Concrete encase major ductbanks below grade shall be polyvinyl chloride (PVC) Schedule 40 conduits in concrete envelop.

B. PVC-coated rigid steel conduit shall be used for all stub-ups and the last 3 feet before exit from earth or entry to structure. The minimum concrete over the outside of the conduit shall be 4 inches.

C. Ductbanks under roadways shall be reinforced with a minimum of four #4 reinforcement bars per each ductbank at a maximum of 18 inches on center parallel to the duct bank and #3 reinforcement bar wraps on 24 inches centers (maximum) for the length of the ductbank. The minimum concrete cover over the reinforcing steel shall be 2 inches. Red concrete is required for all ductbanks.

D. A 3-inch wide detectable plastic marker tape with inscription “CAUTION! ELECTRIC LINES BURIED BELOW” shall be placed above the ductbank.

E. Unless otherwise noted by the City, all ductbanks shall have 36 inches of backfill cover.

7.19 Lighting

A. General: The Engineer shall be responsible for designing interior and exterior lighting for all projects. Lighting illumination levels shall be per Illuminating Engineering Society of North America (IESNA).
B. Interior Lighting: Shall utilize fluorescent, compact fluorescent, metal halide high intensity discharge. Lamps shall be high efficiency rated.

C. Exterior Lighting: Must be ‘Dark Sky Compliant’ to minimize light pollution for adjacent properties and shall utilize High Pressure Sodium HID or Metal Halide HID lamps. Lamps shall be high efficiency rated. Lighting shall also be:

1. Provided with integral mounting pole and bracket shall be capable of withstanding:
   a) Designed for wind levels per site conditions without damage
   b) Designed for seismic levels per site conditions
   c) Equipped with corrosion-resistant hardware and hinged doors or lens retainer.

2. Lighting shall be equipped with one photoelectrical control, which shall be tied into all the fixtures.

3. Hand/Off/Auto Switch for all exterior lights to enable testing shall be located in the interior of a building.

4. Each entrance or exit door to a building shall have a fixture mounted overhead.

5. All exterior and interior light fixtures shall be connected to light switches for manual on/off purposes.

6. Electrical pull boxes shall be identified as City of Surprise Electrical marking.

7.20 Security

A. The Engineer shall contact City to request the most recent security guidelines.

B. Provide separate access for all APS service entrances with the minimum equipment clearances as illustrated in Figure 7.1.

7.21 Electrical Drawings

A. Electrical drawing package shall include the following drawings in addition to other drawings to clearly convey a complete and constructible project.

1. Electrical layout drawings shall identify, but not limited to the following:
   a) All electrical equipment, field instrument, and instrument panel that has electrical connections
b) Plans for all electrical ductbanks/buried conduits

c) Plans and stationed profiles for all major ductbanks, which includes all ductbanks with 480 V and greater as well as handhole/manhole locations

d) Plans for electrical ductbanks up to the facility transformer shall be provided by APS and incorporated into the design drawings

e) Grounding system

f) Electric utility information

g) All conduits shall have unique numbers

h) Demolition equipment.

2. Electrical single-line diagram drawings shall identify, but not limited to the following:

a) Main service entrance equipment, which identifies the protective devices

b) 480 V distribution equipment, motor loads, non-motor loads

c) Load calculations for each piece of electrical equipment

d) 120 V lighting transformer and panelboards

e) 120 V panel schedules

f) Conduit and cable schedules or block diagrams shall show all unique wire numbers.

3. Electrical schematic drawings shall identify, but not limited to the following:

a) The control circuit, which identifies the necessary components to control the equipment based on the Process and Instrumentation Diagrams (P&ID) and the control philosophy

b) The discrete and analog input/outputs from the Programmable Logic Controller to the electrical equipment and instruments

c) Connection diagram showing the wires from the electrical equipment or instruments to associated pieces of equipment

d) Controls shall be such so that the equipment will restart after loss of control power.

7.22 Electrical Specifications

A. The Engineer shall compile electrical specifications for each type of field and panel-mounted electrical equipment and associated appurtenances, which include but is not limited to all equipment, panels, raceways, and conductors included in this Chapter.
B. Work Sequencing and Constraints: The Engineer will include a work sequence in the contract documents that includes known constraints that address:

1. Operation of existing facilities impacted
2. Proposed sequence of construction that minimizes shutdown of facilities and bypass pumping operations.
DIMENSIONS & MINIMUM SAFETY WORKING CLEARANCES
APS TRANSFORMERS - THREE PHASE
112kva - 750kva

INDEPENDENT UTILITY AND POWER COMPANY ACCESS

REAR

FRONT

CITY OF SURPRISE SITE

DIMENSIONS & MINIMUM SAFETY WORKING CLEARANCES
APS STANDARD SWITCHING CABINET - 600AMP

INDEPENDENT UTILITY AND POWER COMPANY ACCESS

REAR

FRONT

CITY OF SURPRISE SITE

NOTES:
1. CLEARANCE AREAS SHALL BE FREE OF OBSTRUCTIONS SUCH AS SHRUBS, TREES AND CACTUS.
2. FINAL GRADE WITHIN THE 10' AND 72' WORKING AREAS SHALL BE SMOOTH AND FREE OF TRIPPING HAZARDS SUCH AS CURBS AND RIVER ROCK

FINAL

CITY OF SURPRISE
Maricopa County, Arizona
Water and Wastewater Guidelines

UTILITY POWER SERVICE ENTRANCE ACCESS

SCALE

7.1

REV.

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