#### SECTION 16000

#### GENERAL REQUIREMENTS FOR ELECTRICAL WORK

#### PART 1--GENERAL

#### 1.01 DESCRIPTION

A. SCOPE:

This section specifies general requirements for electrical work for additions to the Leupp-Dilkon water system. Detailed requirements for specific electrical items are specified in other sections but are subject to the general requirements of this section. The electrical drawings and schedules included in this project manual are functional in nature and do not specify exact locations of equipment or equipment terminations. Description of work below includes, but is not limited to the list provided.

1. Schedule and coordinate work to minimize water system and control outages.

- B. DESCRIPTION OF WORK:
  - 1. Provide Leupp Well. Provide well pump motor starter per Section 16155.
  - 2. Provide Pump Station 0.
  - 3. Provide Pump Station 1.
  - 4. Provide Pump Station 2.
  - 5. Provide Pump Station 3.

6. Provide controls at existing Tolani Lake Tower, connect to existing Microwave system. This site provides telemetry signal relaying between the above and below sites per Drawing Sheet 1-5.

7. Provide controls at existing Dilkon Tower, connect to existing Microwave system. This site provides telemetry signal relaying between the above and below sites per Drawing Sheet 1-5.

8. Provide electrical and controls at Dilkon Tank Site.

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9. Provide instruments, controls, and telemetry units per Division 17.

10. Provide work as specified and per Indian Health Services – Navajo Nation – Standard Drawings.

11. Provide testing per Section 16030 and 17030.

12. Provide arc flash hazard analysis and labeling per Section 16431.

13. Telemetry PLC and touchscreen programming will be provided as specified in Paragraph 17000-1.01 B, coordinate work, programmers, and provide testing.

14. Equipment to be Owner furnished:

a. Only that which is labeled as "EXISTING" on drawings.

15. All replaced or removed items shall be salvaged. Salvaged items shall be properly disconnected to retain their full salvage value and cleaned before turning over to the Owner.

16. As further required in Section 17000.

17. Standby power systems per Sections 16231 and 16260.

#### B. DEFINITIONS:

1. ELEMENTARY OR SCHEMATIC DIAGRAM: A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

2. ONE-LINE DIAGRAM: A one-line diagram shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.

3. BLOCK DIAGRAM: A block diagram is a diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.

4. WIRING DIAGRAM OR CONNECTION SYSTEM: A wiring or connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be

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(a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) a panel layout diagram showing the physical location of devices plus the elementary diagram.

5. ARRANGEMENT, LAYOUT, OR OUTLINE DRAWINGS: An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

# 1.02 QUALITY ASSURANCE

# A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NECA-1	National Electrical Contractors Association – Standard Practices for Good Workmanship in Electrical Contracting
NFPA	National Fire Protection Association
NFPA-70	National Electrical Code (NEC) 2020
NFPA-70E	Electrical Safety in the Workplace
ACI 318	Building Code Requirements for Structural Concrete
	Navajo Area Indian Health Service/NTUA – Technical Provisions 4.0 for Motor Control Center and Tank Control Panel
	Indian Health Service – Navajo Nation – Standard Drawings

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# B. IDENTIFICATION OF LISTED PRODUCTS:

Electrical equipment and materials shall be listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

## C. FACTORY TESTS:

Where specified in the individual product specification section, factory tests shall be performed at the place of fabrication and performed on completion of manufacture or assembly. The costs of factory tests shall be included in the contract price.

#### D. POWER UTILITY:

The power utility is Navajo Tribal Utility Authority (NTUA).

- 1. Coordinate power utility disconnection and connection with the power utility. Provide installations per their requirements.
- 2. Provide submittals per paragraph 1.03 B.

#### 1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 101:

- A. SHOP DRAWINGS:
  - A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining

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acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

- 2. A copy of the contract document Drawings Sheets 2E-2 and 3 (Well), 3E-2 and 3 (PS 0), 4E-2 and 3 (PS 1), 5E-2 and 3 (PS 2), 6E-2 and 3 (PS 3), 7E-1 (Tanks), 9E-1 (Tolani Lake), and 10E-1 (Dilkon Site), relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
- 3. Catalog cuts of equipment, devices, and materials for products to be provided. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply. Submit catalog cuts for only the following:
  - a. Service Entrance Meter Socket.
  - b. Any proposed alternates to specified manufacturers and model equipment.
  - c. Automatic Transfer Switch.
  - d. Temperature Switch.
  - e. Luminaires.
  - f. Electrical equipment and components specified on Drawings.

g. Well pump motor starter shall be submitted separately under Section 16155.

B. POWER UTILITY:

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- 1. After shop drawing review, submit Service Entrance Meter Socket to power utility for review. Provide separate submittals for each of the following sites:
  - a. Leupp Well.
  - b. Pump Station 0.
  - c. Pump Station 1.
  - d. Pump Station 2.
  - e. Pump Station 3.
  - f. Dilkon Tank Site.

#### 1.04 DRAWINGS

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Where the Contractor is required to provide information on drawings as part of the specified work, such drawings shall be prepared on 11 by 17 inch drafting media complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing.

Drawing quality and size of presentation shall be such as to permit 50 percent reduction of such drawings for insertion in operation and maintenance manuals.

#### 1.05 PROJECT/SITE CONDITIONS

#### A. GENERAL:

Unless otherwise specified, equipment and materials shall be sized and derated for the ambient conditions specified.

The elevations vary from the Leupp Well site rising up to PS 3, increasing from elevations of approximately 4,843 to 5,510 feet respectively above mean sea level. Climate conditions are described as follows:

Description	Range of Conditions
Winter	-20 to 40 (°F)
Summer	44 to 110 (°F)
Relative humidity, percent	
Average outdoors	40-60%
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Description	Range of Conditions
Air temperature, degrees F	
Outdoors	53.2 °F Annual Avg
Barometric pressure, inches, mercury	30.01 Annual Avg

Additional conditions which may be applicable are specified in other sections.

#### B. CORROSIVE AREAS:

The following areas are designated as corrosive:

- a. Well pump house chlorine room.
- b. Pump Station 0 chlorine room.

# C. HAZARDOUS (CLASSIFIED) AREAS:

The following areas are designated as hazardous (classified) in accordance with the NEC: None.

D. SEISMIC:

Electrical equipment, supports, and anchorage shall be designed and installed in accordance with the seismic design requirements:

DESIGN PARAMETERS (IBC SECTION 1603)

BUILDINGS & RESERVOIR	S:		
DEAD LOADS: STEEL CONCRETE WATER	490 LBS/CF 150 LBS/CF 62.4 LBS/CF	LIVE LOADS: ROOF (SNOW) BLDG. FLOOR	30 LBS/SF 100 LBS/SF
WIND LOADS: BUILDINGS RESERVOIRS BASIC WI WIND FOI GUST FA	20 LBS/SF (VERT. PRO 3 (AWWA D100-05) IND SPEED 100 MPH RCE COEFFICIENT CTOR G=1.0	DJECTION) WIND IMPORTANCE FLAT Cf = 1.0	EFACTOR I=1.15 CYLINDRICAL Cf = 0.60
SEISMIC: RESERVOIR ANALYSIS SEIS MAPI SPEC	TANK AND RINGWALL : AND FACTORS PER AW MIC IMPORTANCE FAC PED SPECTRAL RESPO CTRAL RESPONSE COE	/WA D100-05 (ASCE 7) TOR: I = 1.15 SITE U INSE ACCELERATIONS: FFICIENTS: Sds = 0.26	SE GROUP: III SITE CLASS: Ss = 0.25g; S1 = 0.06g g; Sd1 = 0.066g
SOIL BEARING ( ENGINEERE	CAPACITIES: ED FILL: 2500 PSF PER	GEOTECH REPORT	

#### 1.06 STORAGE OF MATERIALS AND EQUIPMENT

During the interval between the delivery of equipment to the site and installation, all equipment shall be stored in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

#### PART 2--PRODUCTS

#### 2.01 EQUIPMENT AND MATERIALS

A. GENERAL:

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Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

# B. EQUIPMENT FINISH:

Unless otherwise specified, electrical equipment shall be painted by the manufacturer.

#### 2.02 600 VOLT WIRE AND CABLE

#### A. INSULATION:

1. MEPR/CPE multi-conductor control cable, XLP or CPE insulation and jacket.

- 2. XHHW-2 for single conductors
- 3. THWN for indoor lighting and receptacles
- 4. PVC jacket and insulation for shielded signal cables.
- 5. Coaxial cable is specified in Section 17000.
- 6. Ethernet cable, CAT6 with factory attached RJ-45 connections.
- 7. SOOW or SJOOW for portable cord.
- B. CONDUCTORS:
  - 1. Copper, stranded per ASTM B8.
- C. COLOR CODING:
  - 1. CONTROL CONDUCTORS:

Single-conductor control conductors shall have the following insulation colors for the indicated voltage:

Control Conductor	120V
Power (AC)	Black
Control (AC)	Red

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Control Conductor	120V
Neutral	White
Ground	Green
Power (DC)	Blue
Control (DC)	Violet

# 2. POWER CONDUCTORS:

Power conductors shall have the following insulation colors for the indicated voltage:

Power Conductor	480V	208/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	-	White

Cables may be black with colored 3/4-inch vinyl plastic tape applied at each cable termination. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

# 3. SIGNAL CONDUCTORS:

Signal cable conductors shall be stranded copper and insulation shall be color coded black and white for pairs or black, white, and red for triads.

# D. SPLICING AND TERMINATING MATERIALS:

Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper.

Connectors for wire sizes No. 8 AWG and larger shall be compression tool installed onehole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable. In-line splices and taps shall be used only by written consent of the Construction Manager.

Power conductor splices shall be compression type, made with a compression tool die approved for the purpose, as made by Thomas and Betts Corp., or equal. Splices shall be covered

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with electrical products designed for the application, insulated, and covered with a heatshrinkable sleeve or boot, as specified elsewhere.

Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connections may use the Tyco Electronics removable boot product line.

# E. CORD GRIPS:

Cord grips shall be provided where indicated on the Drawings to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and sized to accommodate the flexible cord.

## F. WIRE MARKERS

Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 AWG or smaller shall have identification sleeves. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

Conductors shall be identified in accordance with paragraph 16000-1.07 B. Adhesive strips are not acceptable.

The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink with figures 1/8 inch high. Sleeves shall be yellow or white tubing and sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

Conductor and Wire Marker Manufacture:

- 1. TMS Thermofit Marker System by Raychem Co
- 2. Sleeve style wire marking system by W. H. Brady Co.
- 3. Or equal.

#### 2.03 RACEWAY

- A. BOXES AND GUTTERS:
  - 1. Well and Pump Station chlorine room: Non-metallic, NEMA 4X.

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2. Well control room, pump station interior, outdoors: Painted Steel, NEMA 3R or 4.

3. Pump Station interior: Painted Steel, NEMA 3R or 4.

# B. SUPPORTS, HANGERS, AND RACKS:

- 1. Well and Pump Station chlorine room: Stainless Steel or Fiberglass.
- 2. Well control room, pump station interior, outdoors: Galvanized Steel.

# C. RACEWAY:

- 1. Well and Pump Station chlorine room: PVC coated rigid steel.
- 2. Well control room, pump station interior, outdoors: Galvanized rigid steel.

3. Underground: PVC schedule 40, taped or PVC coated rigid steel 90 degree elbows at transition to above-ground.

4. Final connections: Liquidtight flexible conduit.

# D. RACEWAY MARKERS:

1. Solid aluminum with 0.036-inch minimum thickness.

2. Raceway number stamped or engraved in 3/16-inch minimum height characters.

- 3. Attached to the raceway with 316 stainless steel wire.
- 4. Engraving per circuits shown on panel schedules and one-line diagrams.
- E. UNDERGROUND MARKING TAPE

Underground detectable marking tape shall be for early warning protection of digging around direct buried cables, conduits, and concrete duct banks. Tape shall be OSHA approved.

Marking tape example: Low density polyethylene plastic, nominally 6 inches wide and 4 mil thickness with metallic lined tape with red polyethylene film on top and clear polyethylene film on the bottom. Tape shall be imprinted with a warning continuously along the length similar to: "CAUTION - STOP DIGGING - BURIED ELECTRIC LINE BELOW."

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Tape Products: Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal.

#### 2.04 COMPONENTS

# A. 120V RECEPTACLES:

Receptacle shall be duplex, 20 ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plugs. Receptacle and plug shall be corrosion resistant, marine duty with polycarbonate weatherproof-in-use covers.

Manufacturers: Hubbell 53CM62/53CM21, or equal.

B. SWITCHES:

Switches shall be 20-ampere with weatherproof/ corrosion resistant neoprene plate. Switches shall be mounted in "FS" type copper-free aluminum or PVC mounting boxes.

Manufactures: Hubbell or Arrow-Hart as follows:

	Hubbell	Arrow-Hart
	with 17CM50 plate	with 2881 plate
Single pole	1281	2991
Double pole	1282	2992
3-way	1283	2993
4-way	1284	2994

# C. DEVICE PLATES:

Device plates shall be corrosion-resistant/marine-duty type.

#### D. LUMIINAIRES:

Provide as specified on drawings. Provide lamps where applicable.

#### E. GROUND RODS:

Ground rods shall be copper covered steel, 3/4-inch diameter and 10-feet long. Rods shall have threaded type removable caps so that extension rods of same diameter and length may be added where necessary.

F. GROUNDING CONNECTORS: Indian Health Service Leupp-Dilkon Water Supply General Requirements for Electrical Work System 156167 16000 - 13 1. Compression connections shall be irreversible, cast copper as manufactured by Thomas and Betts, or equal.

2. Bolted connectors shall be Burndy, O. Z. Gedney, or equal.

3. Exothermic welding products shall be Erico's Cadweld Plus system with a remotely operated battery powered electronic ignition device and moisture resistant weld metal cup for the required mold, or equal.

## G. TEST WELLS:

Provide concrete test well with cover and connect the ground grid extension using a removable connector.

## H. TERMINAL BLOCKS:

Unless otherwise specified, terminal blocks shall be panhead strap screw type. Terminals shall be provided with integral marking strips that permanently identify with the connecting wire numbers as shown on the drawings:

- 1. Terminal blocks for P-circuits (power 208-600 volts)
  - a. Rated not less than the conductor current rating
  - b. Rated less than 600 volts AC.
- 2. Terminal blocks for C-circuits and S-circuits:
  - a. Rated not less than 20 amperes
  - b. Rated less than 600 volts AC.
- 3. Terminals shall be tin-plated.
- 4. Insulating material shall be nylon.

#### 2.05 EQUIPMENT

#### A. TRANSFORMERS:

Provide as specified on drawings.

- B. LOAD CENTERS:
  - 1. Provide as specified on drawings.

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2. Provide metal oxide varistor (MOV) surge protective device (SPD) integral within each panelboard that indicates the status and condition of the SPD, tested per NEMA LS-1, rated IEEE C3 Combined Wave of 20kV and 10kA with 200kAIC internal fusing and listed / labeled per UL 1449.

3. Provide "Circuit Directory and Circuit Identification" in accordance with NEC 408.4. Each circuit shall be of sufficient detail to allow each circuit to be distinguished from other circuits. Circuit identification shall include load location and provide equipment or instrument Tag Number and Tag Description, where shown on the drawings.

# C. SAFETY DISCONNECT SWITCHES:

Heavy duty fused and non-fused disconnect switches with current range of 30 to 600 amperes shall be provided as shown on the drawings with the enclosure type matching the area rating. Provide lock-off provision for a hasp padlock. Provide visible knife blades through a cover viewing window. Provide shielded or insulated line terminals with quick-make / quick-break switch operator. Provide internal barrier kit for additional personnel barrier from accidental contacts with live parts. Provide a legend plate with equipment tag, equipment description, and power feeder circuit source and location identification.

Fuse clips shall be Class R rejection type and sized for UL Class R, one-time, time-delay fuses. Fuse assembly shall have a minimum short circuit capacity of 100,000 amps symmetrical. Provide fuses as shown and one set of spare fuses with each switch.

# D. SERVICE ENTRANCE METER SOCKET:

Provide as specified on drawings.

# E. MOTOR STARTERS:

Provide as specified on drawings and per Spec. 16155.

# F. TELEMETRY PLC:

Provide as specified on drawings and per Spec. 17110.

# G. TEMPERATURE SWITCH:

Weatherproof enclosure, contacts rated 20 amps, adjustable setpoint knob. Settings per Drawing H-100. Honeywell, or equal.

H. DOOR SWITCH:

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Provide as specified on drawings.

# 2.06 NAMEPLATES

## A. MATERIALS:

Nameplates shall be made from laminated phenolic plastic.

- 1. Nominal size: 3/4 inch high by 2 inches long.
- 2. Black backgrounds with 3/16-inch white letters.
- 3. Fastened using self-tapping stainless steel screws.

## B. ENGRAVING:

1. Abbreviations shall be submitted to the Construction Manager prior to manufacture because of space limitations.

2. Nameplate adhesives will not be permitted on the outside of enclosures.

3. Provide nameplate for each electrical equipment item engraved as follows: (EQUIPMENT NAME) / (VOLTAGE) VOLTS.

#### 2.07 PRODUCT DATA

The following information and product data specified under individual specification sections shall be provided in accordance with Section 101.

- 1. Applicable operation and maintenance information on an item-by-item basis in accordance with Section 101. Include final reviewed submittal.
- 2. Test results for motors and electrical systems on the forms specified in Section 16030. A file of the original test results shall be maintained by the Contractor. Prior to acceptance of work, the resulting file shall be provided to the Construction Manager.
- 3. Record documents specified in Section 101 and paragraph 16000-3.03.

# PART 3--EXECUTION

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#### 3.01 GENERAL

# A. CONSTRUCTION:

The work under Division 16 shall be performed in accordance with these specifications.

Refer to the National Electrical Contractors Association's (NECA) National Electrical Installation Standards (NEIS) for Standard Practices for Good Workmanship in Electrical Contracting (NECA-1) as a minimum baseline of quality and workmanship for installing electrical products and systems that defines what is meant by "neat and workmanlike" as required by the National Electrical Code Section 110-12. Specified requirements supersede NECA practices.

Electrical layout drawings are diagrammatic, unless otherwise detailed or dimensioned. The Contractor shall coordinate the location of electrical material or equipment with the work.

Major electrical openings may compromise the structural integrity of the slab and wall elements. Major electrical openings are defined as openings or penetrations greater than two times the wall thickness in any dimension, and include duct bank transitions into a building through structural elements. Major electrical openings shall be constructed according to standard details on the drawings, up to an opening dimension of three feet. For opening dimensions greater than three feet, construct walls and slabs as specifically detailed on the drawings for that case. Major electrical openings proposed by the Contractor shall be submitted to the Structural Engineer of Record for the project for review.

Minor changes in location of electrical material or equipment made prior to installation shall be made at no cost to the Owner.

#### B. CONDUITS IN CONCRETE CONSTRUCTION:

Conduits for power, control and instrumentation may be embedded in and pass through concrete construction subject to the limitations in this paragraph. Where concrete strength or serviceability requirements prevent the direct embedment of conduit, provide adequate support, bracing, and serviceability details:

- 1. Concrete strength shall not be impaired significantly by the embedment of conduits in or through structural sections.
- 2. Conduit layout shall conform to the requirements of ACI 318, Sections 3.3 Aggregates and 6.3 Conduits and Pipes Embedded in Concrete.
- 3. Conduits shall be treated similarly to reinforcing steel for purposes of clearance. In general, code sections require conduit spacing the greater of:

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- a. 1.33 times the maximum concrete aggregate size, clear
- b. Three diameters center to center

Alternate spacing and layout shall be as reviewed and accepted by the Engineer.

4. Conduit and raceway penetrations through walls and slabs where one side is a conditioned or an occupied space and the other side not, or one side has liquid or groundwater contact and the other not, shall be detailed and constructed to prevent liquid and moisture penetration through the wall or slab section for each conduit.

## C. HOUSEKEEPING:

Electrical equipment shall be protected from dust, water and damage. Electrical equipment shall be wiped free of dust and dirt, kept dry, and shall be vacuumed on the inside within 30 days of acceptance of the work.

Before final acceptance, the Contractor shall touch up any scratches on equipment.

Electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction shall be protected.

#### D. ELECTRICAL EQUIPMENT LABELING

Electrical equipment shall have field marked signs and labeling to warn qualified persons of the potential electric arc flash hazards per NEC Article 110.16 Flash Protection.

Electrical equipment shall have NFPA 70E labels installed stating the results of the Arc Flash analysis specified in Section 16431 Short Circuit and Protective Device Coordination Study Report.

Electrical distribution equipment and utilization equipment shall be field labels to identify the power source and the load as specified. Refer to NEC Article 110.22 for Identification of Disconnecting Means installation criteria. Specific information is required such as the equipment tag number and equipment description of both the power source and the load equipment.

# E. MOTOR CONNECTIONS

Verify that the motors are purchased with the correct size motor termination boxes for the circuit content specified as shown on the power single line diagrams or submit custom fabrication

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drawing indicating proposed motor termination box material, size, gasket, termination kit, grounding terminal, motor lead connection method, and motor terminal box connection/support system. Verify the motor termination box location prior to raceway rough-in.

#### F. CONDUCTOR INSTALLATION

An enclosure containing disconnecting means, overcurrent devices, or electrical equipment shall not be used as a wireway or raceway for conductors not terminating within the enclosure. Provide wireways, raceways, termination boxes, or junction boxes external to the enclosure for the other conductors.

## 3.02 TESTING

A. GENERAL:

Refer to Section 16030.

## 3.03 RECORD DOCUMENTS

Contract documents shall be maintained and annotated by the Contractor during construction, including the record drawings specified in Section 101 and as follows.

Record drawings refer to those documents maintained and annotated by the Contractor during construction and are defined as (1) a neatly and legibly marked set of contract drawings showing the final location of piping, equipment, electrical conduits, outlet boxes and cables, including X, Y, and Z coordinates for all fittings and valves after installation and before burial; (2) additional documents such as schedules, lists, drawings, and electrical and instrumentation diagrams included in the specifications; and (3) Contractor layout and installation drawings.

Unless otherwise specified, record drawings shall be full size and maintained in a clean, dry, and legible condition. Record documents shall not be used for construction purposes and shall be available for review by the Construction Manager during normal working hours at the Contractor's field office. At the completion of the work, prior to final payment, all record drawings shall be submitted to the Construction Manager.

Marking of the drawings shall be kept current and shall be done at the time the material and equipment are installed. Annotations to the record documents shall be made with an erasable colored pen or pencil or electronically conforming to the following color code:

Additions - Red Deletions - Green Comments - Blue Dimensions – Graphite or Blue\*

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\*Legibly mark to record actual depths, horizontal and vertical location of underground raceways, cables, and appurtenances referenced to permanent surface improvements.

\*\*END OF SECTION\*

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#### SECTION 16030

## ELECTRICAL ACCEPTANCE TESTING

## PART 1--GENERAL

#### 1.01 DESCRIPTION

#### A. SCOPE:

This section specifies the acceptance testing of electrical materials, power distribution and utilization equipment and circuits. Contractor shall provide all labor, tools, material, power, and other services necessary to provide the specified tests.

#### B. SCHEDULE:

Provide testing for all new equipment and components at the following sites:

- 1. Leupp Well.
- 2. Pump Station 0.
- 3. Pump Station 1.
- 4. Pump Station 2.
- 5. Pump Station 3.
- 6. Tolani Lake Tower.
- 7. Dilkon Tower.
- 8. Dilkon Tank Site.

#### 1.02 REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Electrical Acceptance Testing

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NFPA-70	National Electrical Code (NEC)

#### 1.03 SUBMITTALS

## A. PRE TEST:

1. Functional testing and checkout procedures and schedule shall be submitted in accordance with Section 101.

#### PART 2--PRODUCTS

#### 2.01 TEST EQUIPMENT AND MATERIALS

Test instruments shall be calibrated to references traceable to the National Institute of Standards and Technology and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

#### 2.02 PRODUCT DATA

In accordance with Section 101, the Contractor shall submit the completed test report forms for each site as specified in Part 3 herein. Refer to Section 17030 for requirements of forms 17000-G and H.

#### PART 3--EXECUTION

#### 3.01 TESTING

#### A. GENERAL:

The following specified tests, including correction of defects where found and the subsequent re-testing, shall be completed prior to energization of the equipment or systems. Submit

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all completed test report forms in a 3-ring binder type notebook at the project Substantial Completion date.

A 1,000 volt megohmmeter shall be used for insulation resistance measurements.

# B. INSULATION RESISTANCE MEASUREMENTS:

1. GENERAL: Insulation resistance measurements shall be made on conductors and electrical equipment that will carry current. Minimum acceptable values of insulation resistance shall be in accordance with the applicable NETA-ATS, ICEA, NEMA, or ANSI standards for the equipment or material being tested. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.

2. CONDUCTOR AND CABLE TESTS: The phase-to-ground insulation resistance shall be measured for all circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other load equipment connected. Insulation resistance measurements shall be recorded in a format similar to Form 16000-A and 17000-A contained in Part 3, and submitted for acceptance. Insulation with resistance of less than 10 megohms is not acceptable.

3. MOTOR TESTS: The Installed Motor Test Form, 16000-B, contained in Part 3, shall be completed for each motor after installation and submitted for acceptance. All motors shall have their insulation resistance measured before they are connected.

Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery and when they are connected. Insulation resistance values less than 50 megohms are not acceptable.

Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

4. POWER DISTRIBUTION EQUIPMENT: Transformers, panelboards, and other power distribution equipment shall have their insulation resistance measured phase-to-phase and phase-to-ground. Utilize forms 16000-C and D provided in Part 3 as examples.

5. POWER UTILIZATION EQUIPMENT: Test receptacles and power outlets using a device to verify polarity, grounding, and the correct wiring connections.

# C. FUNCTIONAL TESTING:

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Contractor shall submit a description of proposed functional test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of functional testing.

Prior to functional testing, all protective devices shall be adjusted and made operative.

Prior to energization of associated equipment, perform a functional checkout of all electrical and instrumentation control circuits as specified in the following and in Division 17. Checkout shall consist of energizing each control circuit and operating each control, alarm, safety device, and each interlock, in turn, to verify that the specified action occurs.

## 3.02 PROTECTIVE DEVICE FIELD SETTINGS

The Contractor or Study Firm shall verify, and certify in the acceptance test final report, that the protective device coordination study settings for new and existing equipment based on the Short Circuit and Protective Device Coordination Report specified in Section 16431 have been implemented.

#### 3.03 ARC FLASH SIGN INSTALLATION

The Contractor shall install the Arc Flash Hazard signs per direction from Section 16431 Study Firm.

# 16000-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.:\_\_\_\_\_ Temperature, °F: \_\_\_\_\_

Location of Test	Insulation resistance, megohms
1.	
2.	
3.	
4.	
5.	
6.	
7	

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_

.

Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_

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## 16000-B. INSTALLED MOTOR TEST FORM

Motor Equipment Number: \_\_\_\_\_ Date of test: \_\_\_\_\_

Equipment Driven:

MCC Location:

				Amb	ient temp	۰F
Resistance:						
Insulation resistance phase	se-to-grou	nd megohms:				
Phase A	A Pha			Pł	nase C	
Current at Full Load:						
Phase			Currer	nt, amps		
Phase Current, amps						
Phase			Currer	nt, amps		
Thermal Overload Device: Manufacturer/catalog #				Amp	beres	
Circuit breaker (MCP) setting	:					

Motor Nameplate Markings:

Mfr		Mfr Model		Frame	e		HP	
Volts		Phase		RPM			Service factor**	
Amps		Freq		Ambie	mbient temp rating			C°
Time rating				D	Design	letter**		
	(NEMA 1-10.35)					(NEMA MG-	1.16)	
Code letter				Ir	nsulatio	on class		

\*\*Required for 3-phase squirrel cage induction motors only.

Contractor's Representative

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_

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## 16000-C. DRY TRANSFORMER TEST DATA FORM

 Equipment Tag No.:
 Temperature Rating:

 Description/Location:
 Feeder size/Source:

 Primary Voltage:
 Secondary Voltage:

## A. VISUAL INSPECTION

Transformer Inspection	Pass	Fail	Note
1. Nameplate data as specified			
2. Mechanical condition			
a. Free of dents and scratches			
b. Anchored properly			
c. Shipping brackets removed			
d. Spacing from wall per nameplate			
3. Grounding *			
a. Equipment grounding			
b. System grounding			

#### B. INSULATION-RESISTANCE TESTS:

Perform tests with calibrated megohmeter. Apply 1000 Vdc test voltage for 60 seconds and record readings in megohms at 30-seconds and 60-seconds intervals.

Test Group	Resistance between		30-second reading	60-second reading	Absorption Ratio Index 60-sec. / 30-sec.
	А	GRD			
Primary Winding	В	GRD			
to ground	С	GRD			
Secondary Winding	a	GRD			
to ground with * N-G	b	GRD			
Bond removed	с	GRD			
Primary Winding to	А	a			
	В	b			
Secondary winding	C	c			

Submit resistance readings to the Construction Manager immediately after the tests that are less than the manufacturer's recommended value or less than 10-megohms. Record the Absorption Ratio Index values for future reference. Ratio must be 1.0 or greater, with infinity ( $\infty$ ) equal to 1.0.

Contractor Representative Certified:	 Date
	Dete
Owner Representative Witnessed:	Date

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## 16000-D. MOTOR STARTER TEST FORM

Equipment No.:	Ambient room temperature:
Location:	

#### MECHANICAL CHECK: A.

All bolted connections either bus to bus or cable to bus shall be torqued to the manufacturer's recommendations.

- B. **ELECTRICAL TESTS:** 
  - 1. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute using a megohmmeter at 1000 volts.

Test results (megohms)						
Pha	ase	Phase				
A-GRD		A-B				
B-GRD		B-C				
C-GRD		C-A				

- 2. Provide fuses and overloads in the starter unit to comply with the requirements of NEC, Article 430-52.
- 3. Motor overload heater elements shall be sized and installed based on the actual nameplate full load amperes of the motor connected to the starter.

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_

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## 16000-M. STARTER PANEL TEST DATA FORM

Location:

#### A. PHYSICAL TEST:

List any discrepancies with respect to the panel specifications:

- Dimensions, component layout and wiring specifications. 1.
- 2. Panel and component hardware.
- 3. Quality of Workmanship (wiring and general panel assembly).
- 4. Inventory of all panel parts and documentation (operations and maintenance manual).
- B. FUNCTIONAL TEST:

Components						
Disconnect Switch						
HOA Switch - Auto						
HOA Switch - Off						
HOA Switch - Hand						

#### CERTIFIED

\_\_\_\_\_ Date \_\_\_\_\_

Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_

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**Electrical Acceptance Testing** 

# 17000-A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM

Loop No.:

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

			Continuity Resistance <sup>a</sup>		Insulation Resistance <sup>b</sup>			
			Cond./	Cond./	Shield/	Shield/	Cond./	Shield/
Wire No.	Panel Tie	Field TB	Cond.	Shield	Gnd.	Cond.	Gnd.	Shield
А				(A/SH)				
В			(A/B)					
С			(A/C)					
D			(A/D)					
etc.								

NOTES:

- Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record a. resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.
- b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED

\_\_\_\_\_ Date \_\_\_\_\_

\_\_\_\_\_ Date \_\_\_\_\_ Contractor's Representative

WITNESSED \_\_\_\_\_

Owner's Representative

\*\*END OF SECTION\*\*

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**Electrical Acceptance Testing** 

#### SECTION 16155

#### INDIVIDUAL MOTOR STARTERS

#### PART 1--GENERAL

#### 1.01 DESCRIPTION

A. SCOPE:

This section specifies individual motor starters and motor controllers installed in enclosures other than motor control centers. Refer to drawings for product, device, and circuit requirements.

Provide well pump starter panel per details from NTUA Technical Provisions 4.0 for Motor Control Center 3 Phase Soft Start Pump Panel, as included in the Bid Documents.

B. DERATING:

The starter shall be derated for operation at elevation of approximately 4,843 feet at Leupp.

#### 1.02 QUALITY ASSURANCE

#### A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

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Individual Motor Starters

Reference	Title
NEMA ICS 1	General Standards For Industrial Control and Systems
NEMA 250	Enclosures for Electrical Equipment (1000-Volt Maximum)

# B. LISTED PRODUCTS:

Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose per Section 16000 or UL recognized.

# C. ENVIRONMENTAL CONDITIONS:

Refer to Section 16000.

# 1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 101:

# A. SHOP DRAWINGS:

- 1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owners Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
- 2. A copy of the contract document Drawings Sheets 2E-2 and 3 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to

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Individual Motor Starters

include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

- 3. A copy of the contract document NTUA Technical Provisions 4.0 for Motor Control Center and Tank Control Panel drawings, as included in the Bid Documents, relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
- 4. Catalog cuts of equipment, devices, and materials for products to be provided. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.
- 5. Starter layout drawings, schematic diagrams, and bill of materials.
- 6. Nameplate engraving schedule:
  - a. Indicate engraving by line.
  - b. Character size.
  - c. Nameplate size.
  - d. Panel and equipment tag number and description.
- 7. Verification of fault withstand ratings, and interrupting ratings.

#### PART 2--PRODUCTS

#### 2.01 GENERAL

Equipment material shall be new, free from defects, and industrial grade, as specified. Each type of equipment, component, accessory, and device used throughout the work shall be manufactured by one firm, where possible.

#### 2.02 WELL PUMP STARTER PANEL

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Equipment and components shall be as specified on the drawings referenced in Paragraph 1.01 A, and in this Section where not specified on the drawings.

## A. SOFT STARTER:

Starter shall be a Reduced Voltage Solid State (RVSS) "soft" starter as specified. For starters larger than 100 horsepower, base the layout on the "60 HP to 100 HP Applications" detail as a guide, enlarging the enclosure per starter manufacturer clearance and NEC cable requirements. Starter shall be derated per Paragraph 1.01 B.

#### 2.03 WIRING

Conductors shall be 90-degree C switchboard type. Conductors shall be identified with tag numbers as specified in 16000.

#### 2.04 MANUAL STARTERS

Manual starters shall comprise a horsepower rated quick-make, quick-break, toggle mechanism together with overloads in all phase conductors.

#### 2.05 NAMEPLATES

Nameplates shall be provided in accordance with the requirements of 16000.

#### 2.06 PRODUCT DATA

The following product data shall be provided in accordance with Section 01300:

- 1. Operating and maintenance as specified in Section 101, including:
  - a. Final reviewed submittal
  - b. As-built drawings.
  - c. Record of soft starter configurations.
- 2. A copy of the electrical diagrams in a plastic folder in the units.

# PART 3--EXECUTION

#### 3.01 DEVICE CALIBRATION AND TESTING

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Individual Motor Starters

Size the overload relay heater elements or adjust the solid-state overload device to the actual nameplate full load amperes of the motor connected to the starter.

Adjust motor circuit protector to the lowest setting not causing false tripping.

Configure the soft starter as required for the pump operation. Record settings and include with operations and maintenance manual.

Record the settings on each motor controller and record the settings as part of the Record As-Built drawing submittal.

3.02 TESTING

Local motor starters and circuits shall be tested in accordance with Section 16030.

# \*\*END OF SECTION\*\*

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Individual Motor Starters
# SECTION 16231

#### OUTDOOR STANDBY DIESEL-ENGINE GENERATOR

#### PART 1--GENERAL

#### 1.01 DESCRIPTION

#### A. SCOPE:

This Section specifies the requirements for providing, factory testing, and on-site acceptance testing of complete and operable standby diesel engine driven generating system (GenSet) with an outdoor metal enclosure, ballistic resistant secondary contained belly tank fuel storage container, and the devices and equipment required for the system operation.

The generation system shall include the following:

- 1. Digital control, monitoring, and display system.
- 2. Cooling system.
- 3. Belly tank.
- 4. Exhaust silencer: Mounted inside the enclosure.
- 5. Noise dampening mounting system.
- 6. Sound attenuated outdoor enclosure accessories.
- 7. Accessories:
  - Batteries.
  - Battery charger.
  - Block heater.
- 8. Control system testing.
- 9. Testing with load bank.

#### B. OPERATING REQUIREMENTS:

The electric power generating system shall have ratings as specified with 480 volts, WYE connected generator, three-phase, four-wire, 60-Hertz, 1800 rpm and rated for Standby operation per NEC Article 702. Generator size shown is based on one manufacturer.

Tag No.	Description /	Enclosure
GEN-01	Standby Diesel Fueled Generator/ Leupp Well	Outdoor
GEN-01	Standby Diesel Fueled Generator/ Pump Station 0 (PS 0)	Outdoor
GEN-01	Standby Diesel Fueled Generator/ Pump Station 1 (PS 1)	Outdoor
GEN-01	Standby Diesel Fueled Generator/ Pump Station 2 (PS 2)	Outdoor
GEN-01	Standby Diesel Fueled Generator/ Pump Station 3 (PS 3)	Outdoor

# C. GENERATOR SET SCHEDULE:

#### 1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents

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issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI C57.13	Requirements for Instrument Transformers
IEC 34-5	Rotating Electrical Machines - Part 5: Degrees of Protection by Enclosures for Rotating Machinery
IEC 60529	Guidelines for Panel Testing
ISO	International Organization for Standardization
MG1	Motors and Generators
NEMA MG1	National Electrical Manufacturers Association Standards Publication MG-1
NEMA SG31	Low Voltage Power Circuit Breakers
NFPA 37	National Fire Protection Association Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	National Electrical Code (NEC)
NFPA 110	National Fire Protection Association Standard for Emergency and Standby Power Systems
OSHA	Occupational Safety and Health Act
SAE J 1349	Society of Automotive Engineers Engine Power Test Code
UL 142	Underwriters Laboratories Inc. Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 2085	Underwriters Laboratories Inc. Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids

# B. UNIT RESPONSIBILITY:

1. The Contractor shall cause equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance requirements. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven

component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all systems as provided in the General Conditions of the Contract Documents.

2. The Contractor shall assign unit responsibility, as specified, to the manufacturer of the GenSet provided under this section. This manufacturer is the unit responsibility manufacturer and has unit responsibility, as specified, for the GenSet equipment assembly specified in this section. A completed, signed, and notarized Certificate of Unit Responsibility (Form 11000-C, Paragraph 3.04 of this Section) shall be provided.

# C. DESIGN REQUIREMENTS:

1. ENGINE:

a. RATING: Engine brake horsepower shall be sufficient to deliver full rated GenSet kW/kVA when operated at rated rpm and equipped with all engine-mounted parasitic and external loads such as radiator fans, fuel pumps, and cooling water pumps.

b. FUEL: Diesel engines shall be able to deliver rated power when operating on low-sulfur No. 2 diesel fuel having 35 degree API (16°C, 60°F) specific gravity.

c. FUEL CONSUMPTION: Diesel fuel rates shall be based on fuel having a low heating value (LHV) of 42,780 kJ/kg (18,390 Btu/lb) when used at 29°C (85°F) and weighing 838.9 g/l (7.001 lb. / U.S. gal).

- 2. GENERATOR:
  - a. MOTOR STARTING: Variable speed starters as specified.

b. GENERATOR PERFORMANCE: Voltage dip for motor starting shall not exceed 25% for any individual load step.

3. GENSET START TIME AND LOAD ACCEPTANCE: Engines shall start, achieve rated voltage and frequency, and be capable of accepting load within 10 seconds.

# D. NOISE REQUIREMENTS AND CONTROL:

GenSet enclosure sound pressure level when GenSet is fully loaded shall be not greater than 74 dBA at 7 meters (23 feet) from enclosure.

#### E. MANUFACTURER'S QUALIFICATIONS AND WARRANTY:

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The complete power generation system shall be the product of one manufacturer who has been regularly engaged in the production of complete generating systems for at least twenty-five years.

The supplier shall be the engine-generating system manufacturer's authorized local representative that shall provide installation assistance, start-up services, and Owner's staff training. The supplier shall have 24-hour service availability with factory-trained technicians qualified to perform trouble-shooting, repairs on the system, and warranty compliance services.

The GenSet supplier shall provide the following warranty that includes battery warranty:

Two year parts and labor with travel time included.

# F. MANUFACTURER FACTORY TESTING:

1. FUNCTIONAL TESTS:

a. Functional testing of the complete power generation system final assembly shall be performed at the GenSet manufacturer's factory to assure proper system operation.

b. GenSet shall be load tested after the assembly is installed into the enclosure and operate continuously without stoppage for a period of 8 hours.

- d. GenSet shall operate for one hour at <sup>1</sup>/<sub>2</sub>, <sup>3</sup>/<sub>4</sub>, and full load, at 0.8 power factor or greater. Restart the test, if stopped for any reason.
- 2. PROTOTYPE TEST:

a. The GenSet manufacturer shall certify that engine, generator, and controls have been tested as complete systems in accordance with NFPA 110 of representative engineering models (not on equipment sold).

#### 2. SOUND TEST:

a. Provide a GenSet factory test for sound pressure level measured in accordance with Institute of Electrical and Electronics Engineers (IEEE) Standard 85, Test Procedure for Airborne Sound Measurement on rotating electrical machines. Refer to paragraph 1.02 for sound test criteria.

#### G. SHIPMENT, HANDLING, AND STORAGE:

The equipment shall be protected during shipment, handling, and storage per General Requirements.

# 1.03 ENVIRONMENTAL CONDITIONS

# A. GENERAL:

The GenSet manufacturer shall verify that the diesel engine is correctly sized and is capable of driving the generator with all accessories in place and operating, at the generator's kW rating after derating for the range of temperatures expected in service and the project site altitude.

## B. SEISMIC:

Equipment and supports shall be braced per paragraph 16000-1.05 D.

# C. SITE CONDITIONS:

Refer to paragraph 16000-1.05 A.

# 1.04 SUBMITTALS

The following submittals shall be provided in accordance with the requirements of Section 101.

# A. SHOP DRAWINGS:

- 1. A copy of this specification section, with addendum updates included, paragraph 16000-1.05 A, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
- 2. Completed Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section. No other submittal

material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

- 3. A copy of the contract document electrical drawings 2E-1 and 2E-3 (Well), 3E-1 and 3E-3 (PS 0), 4E-1 and 4E-3 (PS 1), 5E-1 and 5E-3 (PS 2), and 6E-1 and 6E-3 (PS 3), with addendum updates included, marked to show deviations. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
- 4. Manufacturer and manufacturer's type designation.
- 5. Manufacturer's catalog and/or other data confirming conformance to specific design, material and equipment requirements including:
  - a. ENGINE:
    - 1) Type, aspiration, compression ratio, and combustion cycle.
    - 2) Bore, stroke, displacement, and number of cylinders.
    - 3) Rotational speed, RPM.
    - 4) Engine lubricating oil capacity.
    - 5) Engine coolant capacity without radiator.
    - 6) Engine coolant capacity with radiator.
    - 7) Coolant pump external resistance (maximum).
    - 8) Coolant pump flow at maximum external resistance.
    - 9) Exhaust back-pressure (maximum allowable pressure).
    - 10) Combustion air inlet flow rate.
    - 11) Exhaust gas, flow rate, stack temperature.
    - 12) Exhaust system back pressure (maximum).
    - 13) Heat rejection to:
      - a. Coolant.
      - b. Aftercooler.
      - c. Lube oil.
      - d. Exhaust.
      - e. Atmosphere.
    - 14) Fuel Consumption:
      - a. 50% load.
        - b. 75% load.
        - c. 100% load.
    - 15) Fuel supply system including belly tank and level alarm devices.
  - b. GENERATOR:

- 1) Model.
- 2) Frame.
- 3) Voltage.
- 4) kW.
- 5) Power Factor.
- 6) Frequency.
- 7) Insulation class.
- 8) Number of leads.
- 9) Weight, total.
- 10) Weight, rotor.

# c. EFFICIENCY AT RATED VOLTAGE:

- 1) Efficiency at 0.8 power factor for 50% load.
- 2) Efficiency at 0.8 power factor for 75% load.
- 3) Efficiency at 0.8 power factor for 100% load.

# d. RADIATOR:

- 1) Model.
- 2) Type.
- 3) Heat Rejection: BTU/Hour.
- 4) Fan drive ratio.
- 5) Coolant capacity, radiator.
- 6) Coolant capacity, radiator and engine.

# e. GENSET WITH ENCLOSURE DIMENSIONS:

- 1) Dimensions: Length, width, height.
- 2) Weight: Dry and wet.
- 3) Vibration isolators.
- f. POWER RATING: Nominal full capacity standby kW at power factor specified on the Drawings in the Load Summary, and corresponding kVA rating.
- 6. Drawings:
  - a. General dimensions drawings showing overall GenSet measurements, mounting location, and interconnection points for load leads, fuel, exhaust, cooling and drain lines.
  - b. General dimension drawings for fuel supply and storage system including interconnection points, fuel and drain lines, and level and leak detection equipment, terminal-boxes and panels.

- 7. Wiring diagrams, schematics and control panel outline drawings published by the manufacturer in Joint Industrial Council (JIC) format for controls and switchgear showing interconnected points and logic diagrams for use by contractor and owner.
- 8. Generator manufacturer sizing calculations and signed certification that the generator will consistently start the Running Load specified on the Drawings while operating all other power loads specified

# B. STRUCTURAL BRACING AND ANCHORAGE:

Provide submittal separately from and after review of the Shop Drawings submittal. Provide the following.

1. A copy of this specification section and a copy of 16000-1.05 D, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A <u>check mark</u> shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

- 2. Manufacturer's written certification confirming that the equipment bracing complies with the specified requirements.
- 3. Manufacturer's scaled drawings for the equipment showing internal assembly bracing.
- 4. Weight for each complete equipment assembly.
- 5. Manufacturer's recommended anchorage requirements in accordance with the specified requirements, if available from the Manufacturer.

# C. FINAL STRUCTURAL BRACING CERTIFICATION:

Provide the final reviewed complete Structural Bracing submittal including review comments for review by the Owner's Authority Having Jurisdiction.

# D. SIGNS:

Contractor shall submit signs to be provided per NEC 702.7. Include size and engraving/language.

# PART 2--PRODUCTS

#### 2.01 MANUFACTURERS

The Owner and Construction Manager require the following candidate manufacturer to provide the equipment and/or products to be furnished under this section. The Owner and Construction Manager believe the manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named manufacturer's standard product will comply with the requirements of this Section. For the purposes of standardization, personnel training and experience, and commonality of existing spare parts at other facilities, the manufacturer shall be as follows:

- 1. Cummins/Onan.
- 2. Caterpillar.

#### 2.02 ENGINE EQUIPMENT

A. GENERAL:

The engine shall be a single stationary, liquid cooled, 1800 rpm, four-cycle design, direct injection engine with forged steel crankshaft and connecting rods.

Systems with dual engine-generators in one enclosure will not be permitted.

The engine cylinder block shall be cast iron with replaceable wet liners with four valves per cylinder. Provide 6, 12, or 16 cylinders engine with turbocharger and after-cooled, as required by the GenSet Manufacturer.

The GenSet engine shall not be manufactured with any Class I ozone depleting substances (ODS) as defined by Federal Register Vol. 57 No. 86. The GenSet shall be precertified EPA Tier-2 emission requirements.

# B. STRUCTURAL STEEL FRAME:

The generator, radiator, and engine shall be securely mounted on a heavy welded steel frame structure frame that is stiffened and cross-braced to provide a rigid mounting base.

# C. ENGINE EQUIPMENT:

The engine shall be equipped with manufacturers standard air filters, fuel filters, pressure gauges, lubricating oil cooler, filters, and pressure gauge, water pump and temperature gauge, service hour meter, flywheel, and flywheel housing when applicable.

# D. ENGINE FUEL SYSTEM:

1. FUEL/WATER SEPARATOR: A fuel/water separator shall be provided to protect the fuel system from water damage.

2. FUEL LINES: Flexible fuel lines between engine and fuel supply shall be provided to isolate vibration.

3. FUEL SYSTEM MAINTENANCE: The fuel transfer pump, injection pumps, rack and pinion assembly, and timing mechanism shall be maintenance and adjustment free for the life of the equipment. The fuel filter shall not require changing more frequently than once per year or every 250 hours. Provide a fuel filter with spill containment and catch pan for about three gallons of fuel.

# E. GOVERNOR:

1. GENERAL: The engine governor shall control engine speed and transient load response. The governor shall be selected, installed, and tested by the GenSet manufacturer.

2. SPEED CONTROL: The engine governor shall be an electronic speedcontrol actuator. Speed droop shall be 0 (isochronous) from no load to full rated load.

3. FREQUENCY REGULATION: The steady state frequency regulation shall be within 0.25%. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear.

4. REMOTE SPEED CONTROL: A provision for remote speed adjustment shall be provided.

5. ACTUATOR: The forward acting actuator shall move to the minimum fuel position in the event of a DC power loss.

# F. COOLING SYSTEM:

1. GENERAL: The engine jacket water cooling system shall be a closed circuit design with provision for filling, expansion, and de-aeration.

The cooling pump shall be driven by the engine. Auxiliary coolant pumps required for heat exchangers or separate circuit after-cooling shall be engine driven.

The cooling system shall tolerate at least 172 kPa (25 psi) static head. Coolant temperature shall be internally regulated to disconnect external cooling systems until operating temperature is achieved.

2. ENGINE MOUNTED RADIATOR: Heat rejected to the engine jacket water shall be discharged to the atmosphere through a close-coupled radiator.

3. COOLANT: The unit shall have an antifreeze / coolant mixture. The radiator shall cool the jacket water while the engine is operating at full site capability and 0.062 kPa (0.25 inch water column) external air restrictions.

Additional restriction affecting airflow shall not limit the radiator's capability to adequately cool at maximum site temperature. Provide air flow to meet ambient conditions at specified ratings at 100% rated connected load.

4. FAN AND BELT GUARDING: The fan, fan drive, and fan belts shall be covered with 14 gauge punched steel mesh guarding for personnel protection. The guarding shall conform to Independent Electrical Contractors (IEC) 34-5, International Organization for Standardization (ISO) and Occupational Safety and Health Administration (OSHA) standards.

5. RADIATOR FAN: The radiator-cooling fan shall be a propeller type driven from the engine with the air drawn from the engine side and exhausted through the radiator core.

6. INLET AIR SYSTEM: The engine air cleaner shall be engine mounted with maintenance access. The maximum restriction to the combustion air inlet shall not exceed engine manufacturer requirements where external ducting provided.

# G. EXHAUST SYSTEM:

1. GENERAL: The engine exhaust system shall discharge combustion gases safely and without leakage with minimum restriction. The critical sound silencer shall be designed for minimum restriction without excessive back-pressure.

Engine exhaust piping shall be Schedule 40 carbon steel type 321 or 316 with long radius 90 degree bends. Piping shall be installed with 9 inch minimum clearance from combustible material or incorporate appropriate insulation and shielding, as appropriate for personnel safety. Provide a stainless steel flexible connection between the engine and exhaust piping.

Exhaust piping shall be supported and anchored to prevent weight or thermal growth being transferred to the engine. Flexible expansion fittings provided to accommodate thermal growth. Support dampers and spring isolators provided to isolate vibration.

Long runs of exhaust piping shall be pitched away from the engine and water traps installed at the lowest point. Provide a 1-inch diameter capped sample port for emissions testing. Provide ports 90-degrees apart on a straight section of exhaust piping.

Exhaust stacks shall be extended to avoid fumes and odors inside enclosure and installed to minimize noise.

2. SILENCER-CRITICAL: The silencer shall be residential quality.

## H. STRUCTURAL BRACING:

Generator assembly shall be braced by the Manufacturer per the seismic requirements specified. Submit bracing information.

# 2.03 THERMAL INSULATION WRAP

A. GENERAL:

Provide thermal insulation wrap or other acceptable method for insulating the hot surfaces on generator engines for personnel and structure safety.

#### B. SURFACES:

Hot surfaces within the enclosure to protect personnel and structure as recommended by the manufacturer.

#### C. EXECUTION:

Provide thermal insulation blanket or metal guard that is easily removed without damaging the blanket during maintenance or repair of the engine.

Stainless steel removable lacing shall be provided. The use of "hot rings" for binding edges or securing blankets is unacceptable.

#### 2.04 GENERATOR SYSTEM

#### A. GENERATOR:

The generator shall be synchronous, four pole, revolving field, pre-lubricated bearing, air cooled by a direct drive centrifugal blower fan, and directly coupled to the engine with flexible drive discs.

The armature shall have skewed laminations of insulated electrical grade steel, two-thirds pitch windings. The rotor shall have amortissuer damper windings of layer-wound, mechanically-wedged winding construction. The rotor shall be dynamically balanced.

Insulation system components shall meet NEMA MG1 temperature limits for a Class H insulation system. Actual temperature rise measured by resistance method shall not exceed 125 degrees Centigrade to provide additional allowance for internal hot spots.

The generator insulation systems shall be suitably impregnated for operation in severe environments for resistance to sand and other air-born contaminants.

# B. EXCITER:

A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear loads on the generator.

The PMG shall sustain field excitation power for optimum motor starting and shall sustain short circuit current for selective operation and coordination of system overcurrent devices.

The PMG exciter insulation systems shall be suitably impregnated for operation in severe environments for resistance to sand and other air-born contaminants.

# C. VOLTAGE REGULATOR:

The automatic voltage regulator shall be temperature compensated, digitally controlled pulse width modulated solid-state design, and include over-voltage and over-current protection functions.

Over-voltage protection shall sense generator output voltage, In the event of regulator failure or loss of reference, the regulator shall shut down its output on a sustained over-voltage of one-second duration.

Over-excitation protection shall sense regulator output and shut down its output if overload exceeds ten seconds duration. Both over-voltage and over-excitation protection shall be latched, requiring the generator to be stopped for reset.

Generator output voltage shall be maintained within 1% of rated value for any load variation between no load and full load and drift no more than within 0.5% of rated value at constant temperature.

# D. CIRCUIT BREAKER:

The generator mounted circuit breaker shall be mounted and connected in a guarded drip proof freestanding enclosure meeting IEC 144 requirements, and provided with adequate space for customer power cable lug connections. Cable lugs by supplier, refer to the electrical drawings for circuit conductor sizes and numbers.

Provide the following:

1. Molded case circuit breaker rated for 100% current, 3-pole, single-throw, stationary-mounted with manual operating handle, overload and short circuit trips, complete with cable lugs.

- 2. Circuit breaker shall be UL labeled and rated for 600-volt circuits and provided with a solid state over-current trip device.
- 3. A circuit breaker with a 24 Vdc shunt-trip unit wired to terminal board.
- 4. Three current transformers with 5-ampere secondary windings for the ammeter display, as needed.
- 5. National Electrical Code required working access space around the Circuit Breaker enclosure, including maximum height above finished grade.
- 6. Provide lugs to accommodate cable size and quantity shown.

#### 2.05 ENGINE-GENERATOR SYSTEMS

#### A. ENGINE STARTING SYSTEM:

The engine starting system shall include 24 Vdc starting motor(s), starter relay, and automatic reset circuit breaker to protect against butt engagement.

Required cables furnished and sized for power feeder circuit requirements and capable of starting the specified engine within 10 seconds at the elevation and ambient environmental conditions specified herein.

B. WATER JACKET HEATER:

Jacket water heater(s) shall be provided to maintain coolant temperature of 32°C (90°F) while the engine not running. Heaters shall accept 240 Vac single phase power and include thermostatic controls.

C. BATTERIES:

Batteries for GenSet starting and control shall be selected and supplied by the GenSet manufacturer. Battery warranty shall be the responsibility of the GenSet manufacturer. Batteries shall be protected from engine fuel leaks.

Batteries shall be maintenance free, lead acid type with through-partition connectors and mounted near the starting motor. Batteries shall be mounted on a corrosion resistant or coated steel battery rack close to the starting motor as practical and allow personnel access for inspection and maintenance.

Starting batteries shall be rated 24 Vdc that includes the sizing requirements to allow for engine oil viscosity, ambient starting temperature, project elevation, and accessories.

#### D. ALTERNATOR:

Indian Health Service Leupp-Dilkon Water Supply System 156167

An engine-mounted belt-driven battery charging alternator shall be installed with an automatic voltage regulator. Alternator and regulator suitable for the application with a rating of 24 Vdc output.

# E. BATTERY CHARGER:

A dual rate 10-ampere battery charger shall be provided that shall accept 120 Vac single phase input to provide 24 Vdc output. Amperage rating as required for batteries provided.

The battery charger shall be fused on the AC input and DC output, and incorporate current limiting circuitry to avoid the need for a crank disconnect relay. The charger shall be rated for operation at plus 50°C ambient. Charger voltage regulator shall be temperature compensated.

A voltage power switch shall be mounted on the face of the charger and shielded from accidental switching. The charger shall include an AC ammeter and voltmeter, a failure malfunction alarm switch, and be housed in an enclosure suitable for mounting inside the outdoor enclosure.

# 2.06 FUEL STORAGE SYSTEM

Provide 24 hour rated belly fuel tank, fuel level indication, and diesel fuel flowmeter indicating flow rate and flow total.

- 1. Tank shall be UL 2085 ballistic resistant.
- 2. Tank shall have UL 142 secondary containment with leak detector.
- 3. Provide low fuel and tank leak alarms to generator controller.

# 2.07 OUTDOOR ENCLOSURE

# A. GENERAL:

The acoustical enclosure shall house the engine generator and the auxiliary equipment required for the electric power generating system. The enclosure shall be a weather-protected sound attenuated enclosure complete with fire extinguisher and the following modification and features:

# B. SOUND ATTENUATION ENCLOSURE:

The acoustical enclosure shall be constructed of 14-gauge minimum galvanized steel modular panel construction with 4-inch acoustic insulation and perforated liner. The enclosure shall be designed for a minimum wind load of 125 mph, roof load of 50-pounds per square foot, and floor load of 200-pounds per square foot if equipped with a floor.

Galvanized perimeter frame structure bracing shall allow the enclosure to be removed as a unit without disassembly. Provide crane lifting eyes where required to move enclosure. Provide peaked roof for rain run-off.

Provide fixed vane weather-proof acoustic intake louvers with hinged access and sized per the engine's cooling and combustion airflow requirements.

Provide interior workspace around both sides, and the rear of the generator.

Provide NEC required 3-1/2 foot clear workspace in front of the generator circuit breaker and generator control panel.

C. DOORS:

Enclosure shall contain four personnel outside entrance double-gasketed doors for entering the engine/generator compartment. Doors shall be fabricated from 14-gauge galvaneal with heavy duty continuous stainless steel piano hinge with stainless steel fasteners and pins.

Outside door latch mechanism shall be flush mounted and lockable.

No hardware shall protrude beyond the perimeter of the enclosure to facilitate normal handling and shipping aboard container ships or by highway semi-tractor trailer.

# D. SURFACE PREPARATION AND PAINTING:

Surface preparation and painting for the enclosure by the container manufacture shall be as follows:

- 1. Steel sheeting shall be galvanized steel.
- 2. Steel components shall be force dried and painted with a two-part epoxy primer and high gloss finish polyurethane topcoat.
- 3. Caulk open seams with a sealant to prevent rust seepage after painting.

# E. EXTERIOR COLOR:

The enclosure exterior shall be manufacturer standard finish, suitable for field applied coating.

- F. NOT USED
- G. NOT USED
- H. NOT USED
- I. ELECTRICAL CONNECTIONS:

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The generator main circuit breaker shall be housed in a NEMA-12 gasketed metal enclosure installed within the enclosure. Provide a NEMA-12 gasketed terminal box for control and instrumentation wiring, separated from power connections, and show terminal box location in the submittal documentation.

## J. VENTILATION:

Hinge the fixed vane intake louvers for access and size per the engine's cooling and combustion airflow requirements. Separate the intake louver from the exhaust louver.

Orient each louver to minimize superheating of the intake air. Use air directional acoustic barrier plates to mitigate sound escaping from the enclosure while not impeding airflow necessary for combustion and cooling. Install water separator to catch and drain of standing water on the louvers.

A sound insulated baffle shall be installed six inches below the opening of the fan and shall extend twelve inches beyond the fan opening.

K. SOUND ATTENUATION:

The enclosure shall be sound attenuated with composite sandwich construction of perforated metal enclosure either non-flammable mineral fiber or fiberglass. The interior wall surface shall be 20-gauge perforated aluminum metal construction.

#### 2.08 CONTROLS

A. ENGINE-GENERATOR CONTROL PANEL:

The control panel shall be designed and built by the engine-generator manufacturer and mounted near the generator with vibration dampening mounting devices.

Provide a 100 percent solid state microprocessor based control circuitry, sealed dust tight, watertight modular components, and digital instrumentation. Provide IEC-IP52 or NEMA 12 enclosure ratings. Comply with IEC 60529 or NEMA standards for enclosure protection. Label the control panel with ISO symbols.

Display critical parameters such as operating hours, engine RPM, battery DC volts, oil pressure, jacket water temperature, including the specified engine and electrical parameters.

#### B. ENGINE MONITORING DEVICES:

Engine monitoring signals provided by engine mounted lubricating oil pressure and coolant temperature transducers shall communicated over a serial data link through a Data Sending Unit to the control panel receiving module. The safety logic shall shut the engine down if the serial data link is lost.

C. CONTROL FUNCTIONS:

Provide control panel front mounted devices such as generator voltage control device, ammeter/voltmeter phase selector switch, control selector switches, and pushbuttons. Provide control and monitor devices identified and labeled with ISO symbols.

Provide start-stop logic for cycle cranking and cool down operation and red-mushroom head emergency-stop maintained pushbutton.

## D. CONTROL WIRING:

Number 16 AWG stranded wire and control panel ground wire.

Number 12 AWG with green and yellow striped insulation rated.

Conductors shall be rated 90°C 600 Vac insulation with UL or CSA listing.

Provide wire identification on the conductor 6-inches from the terminal and protect wire from sharp bends and metal edges.

Provide Form-C dry contacts rated at 2 amps for remote customer alarming:

- 1. Run status.
- 2. Trouble (pre-alarm) Alarm.
- 3. Shutdown (fail) Alarm.
- 4. Low Fuel Alarm.
- 5. Fuel Leak Alarm.

Provide external emergency stop pushbutton.

# E. ALARM AND SHUTDOWN CONDITIONS:

Indicate the following alarm and shutdown conditions and provide a RESET device to clear fault:

- 1. Low oil pressure: pre-alarm.
- 2. High engine temperature: pre-alarm.
- 3. Low engine temperature: pre-alarm.
- 4. Low fuel: pre-alarm.
- 5. Low battery DC voltage: pre-alarm.
- 6. Generator output circuit breaker (trip or off): alarm.
- 7. Generator overload: alarm.
- 8. Low oil pressure: shutdown.
- 9. High engine temperature: shutdown.
- 10. Low coolant level: shutdown.
- 11. Over-crank: shutdown.
- 12. Over-speed: shutdown.
- 13. Over-voltage: shutdown
- 14. Under-voltage: shutdown.

- 15. Under-frequency: shutdown.
- 16. High battery voltage alarm.
- 17. Low battery voltage alarm.
- 18. Normal battery voltage indication.
- 19. Battery charger malfunction alarm.

#### F. METERING:

Provide digital metering with 0.5% accuracy. Provide true RMS indication that includes the total harmonic voltage and current content:

- 1. Voltmeter.
- 2. Ammeter.
- 3. Frequency meter.
- 4. Phase select switch.
- 5. Running time.

# G. ALARM MODULE:

Provide integral digital alarm annunciator for indication and audible alarm per NFPA 110 on the engine-generator control panel. Provide lamp test switches, alarm horn silence-button, and first-out alarm detection.

#### 2.09 SPARE PARTS

Spare parts are not required as they shall be normally stocked locally by the manufacturer's local dealer.

#### 2.10 PRODUCT DATA

The following information shall be provided:

- 1. Operation and maintenance information as specified in 101. In addition the following:
  - a. Final reviewed submittal.
  - b. Operating instructions with description and illustration of engine and generator controls and monitors.
  - c. Manuals that illustrate and list assemblies, subassemblies and components, except the standard fastening hardware.
  - d. Preventative maintenance instructions for daily, weekly, monthly, biannual, and annual maintenance requirements. Include a lubrication chart for all components.

- e. Routine test procedures for electronic and electrical circuits including the generator.
- f. Troubleshooting chart covering the complete GenSet with a description of trouble, probable cause, and suggested remedy.
- g. Recommended spare parts list showing consumables anticipated during routine maintenance and test.
- h. Wiring diagrams and schematics showing function of electrical components.
- i. Complete final submittals including As-Built drawings.
- j. Manuals and books described above shall be contained in rigid plastic pouches.
- k. Warranty verification statements published by the Manufacturer.
- 1. Location and description of suppliers parts and service facility, including parts inventory and number of qualified GenSet service personnel.
- m. Installation requirements showing clearances required for maintenance purposes: Access to main breaker, oil fill line, fuel fill line, etc.
- 3. Training certification Form 11000-B specified in paragraph 16231-3.04.
- 4. Field test reports as specified.

# PART 3--EXECUTION

# 3.01 INSTALLATION

A. GENERAL:

The GenSet shall be installed and connected in accordance with manufacturer's recommendations and the installation shall be certified on Form 11000-A as specified in paragraph 16231-3.04.

Verify the equipment pad is sized for the GenSet size per submittal information, level, with ground pad installed.

B. SIGNS: Indian Health Service Leupp-Dilkon Water Supply Outdoor Standby Diesel-Engine Generator System 156167 16231 - 21 Provide NEMA MG1-22.61 GenSet nameplate.

Provide laminated equipment, device, and panel nameplates per specification Section 16000.

Provide signs per NEC 702.7.

# C. CONDUIT TRANSITIONS AT SLAB:

Connection from underground conduits to GenSet equipment shall transition via PVC coated flexible steel conduits. Loose or open cabling will not be permitted.

# D. PROTECTION POST BARRIERS:

Provide a minimum 4-inch diameter concrete filled 36-inch high posts around the GenSet. Post shall be removable with locking pin device to keep in place. Provide post at each corner within 3-feet from the enclosure and with 3-feet between posts. Coordinate post locations with submittal for enclosure access.

# E. INTRUSION SWITCHES:

Provide intrusion switch for each enclosure doorway. Switches shall be NEMA 4, with Form C contacts.

F. EMERGENCY STOP:

Provide external emergency stop pushbutton, NEMA 4 with control station and engraved nameplate: STANDBY GENERATOR EMERGENCY STOP.

# 3.02 FIELD INSPECTION AND TESTING

A. NOT USED

# PRE-DELIVERY SUPPLIER FACILITY TESTING:

Prior to delivery of the GenSet to the project site, test the GenSet to verify it is free of defects, starts automatically, and carry full load. Test shall be performed at the facility of the system manufacturer's authorized supplier.

The testing shall be done on dry type, resistive load banks capable of precise incremental loadingd.

Provide separate test grade instrumentation to monitor the GenSet using the load bank. The GenSet monitoring instruments shall be read and compared to the amperage and voltage on each phase. Both readings shall be recorded and compared in the test report.

# C. NOT USED

#### D. ON SITE POST-INSTALLATION TESTING:

Following installation, the following tests shall be performed by the system manufacturer's qualified representative in the presence of the Owner's representative.

Pre-start Checks:

- 1. Oil level
- 2. Water level
- 3. Day tank fuel level
- 4. Battery connection and charge condition
- 5. Engine to control interconnects
- 6. GenSet intake/exhaust obstructions
- 7. Engine ventilation obstructions
- 8. Removal of all packing materials

# E. FIELD TESTS:

The GenSet field test shall be performed by factory trained technicians at the project site with test equipment, facilities, and consumables including fuel and lubricants provided by the supplier. Provide a full tank of diesel fuel when the testing is completed and the GenSet is available for operation.

Owner's representatives shall witness the field tests. Contractor shall provide to the Construction Manager written notice of the date field testing will commence a minimum of two weeks prior to that date.

The following field tests shall be conducted:

- 1. Check electrical exhaust, fuel and water connections for proper size, continuity and tightness of fittings.
- 2. Check fluids for appropriate levels and jacket water heater operation.
- 3. Start-up engine and make initial start-up check of operational equipment.
- 4. Upon completion of initial start-up and system checkout, schedule the witnessed field test to demonstrate load carrying capability, stability, voltage and frequency.
- 5. Operate the GenSet for l-hour for proper engine break-in and record water temperature, fuel pressure, oil pressure, ambient air temperature, voltage, amperage, frequency, kilowatts, and power factor.
- 6. Operate a minimum of 4-hours under full load with consumables necessary for testing furnished by the bidder.

- 7. Return to normal power source and test the ATS transfer from normal power to standby power and the ATS monitoring functions by simulating the loss of normal power source.
- 8. Test the ATS initiated "GenSet Start" condition with the load bank.
- 9. Run the generator for test duration; monitor the oil and water temperatures and record readings every fifteen minutes.
- 10. Test the GenSet safety devices using methods recommended by the manufacturer.
- 11. Setup the unloaded run at the conclusion of the test and the retransfer to normal power to allow engine to cool before engine shutdown.
- 12. Notify the Owner's representative of problems and the mitigation plan.
- 13. Submit the formal Test Results Report for approval.

# F. DEMONSTRATION:

Demonstrate proper operation of generator, transfer switch, and PLC monitored signals to the Construction Manager. Demonstration to include simulation of power failure with well or booster pumps running, generator start and pump(s) restart, restoration of power failure, pump(s) transfer to normal power and restart, and generator stop.

# 3.03 TRAINING

The Contractor shall contract with the GenSet manufacturer to provide two sets of 4-hours of training. Arrange and schedule the training with the Owner.

Training shall include the requirements of Section 101 and the following:

- 1. Diesel Engine theory
- 2. AC Generator theory
- 3. Operational information for the specific equipment provided.
- 4. Operation of the equipment in automatic and manual modes.
- 5. Troubleshooting.
- 6. Routine maintenance.

Training shall be certified on Form 11000-B as specified in paragraph 16231-3.04.

# 3.04 REFERENCE FORMS

#### 11000-A. MANUFACTURER'S INSTALLATION CERTIFICATION FORM

Contract No:	Specification section:
Equipment name:	
Contractor:	
Manufacturer of equipment item:	
The undersigned manufacturer of the e installation of the equipment and that the equipm with the manufacturer's recommendations, and t	equipment item described above hereby certifies that he has checked the nent, as specified in the project manual, has been provided in accordance hat the trial operation of the equipment item has been satisfactory.
Comments:	
Date	Manufacturer
	Signature of Authorized Representative
Date	Contractor

Signature of Authorized Representative

#### 11000-B. MANUFACTURER'S INSTRUCTION CERTIFICATION FORM

Contract No:	Specification section:	
Equipment name:		
Contractor:		
Manufacturer of equipment item:		

The undersigned manufacturer certifies that a service engineer has instructed the wastewater treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)	
Start-up procedure reviewed	
Shutdown procedure reviewed	
Normal operation procedure reviewed	
Others:	
Maintenance Check List (check appropriate spaces)	
Described normal oil changes (frequency)	
Described special tools required	
Described normal items to be reviewed for wear	
Described preventive maintenance instructions	
Described greasing frequency	
Others:	

Manufacturer

Signature of Authorized Representative

Date

Date

Signature of Owner's Representative

Signature of Contractor's Representative

# 11000-C. UNIT RESPONSIBILITY CERTIFICATION FORM

(Project Title)	
CERTII for Sp	FICATE OF UNIT RESPONSIBILITY ecification Section
	(Section title)
In accordance with paragraph 16231-1.02 equipment ("manufacturer") accepts unit under specification Section <u>,</u> and f and	2 B of the contract documents, the undersigned manufacturer of driven t responsibility for all components of equipment furnished to the Project for related equipment manufactured under Sections,,
including but not limited to drivers, support appurtenances to be furnished to the Pro- necessary, the requirements for associate that all specified components are compatib and design requirements whether or not th any condition that problems in operation due to incompatibility of any components condition or void any warranty for the per incompatibility of any components covere Our signature on this Certificate of Unit Re warrant the workmanship, quality, or perfor Sections,, and O unaffected.	orts for driving and driven equipment and all other specified ject by manufacturer. And, we have further reviewed, and modified as d variable speed drives and motor control centers. We hereby certify be and comprise a functional unit suitable for the specified performance e equipment was furnished by us. We will make no claim nor establish for the product provided under this specification Section are covered by this Certificate of Unit Responsibility. Nor will we rformance of the product of this specification Section due to ed under this Certificate of Unit Responsibility. esponsibility does not obligate us to take responsibility for, nor to prmance of related equipment provided by others under specification ur obligation to warranty all equipment provided by us shall remain
Notary Public	Name of Corporation
Notary Public Commission expiration date	Name of Corporation       Address
Notary Public Commission expiration date Seal:	Name of Corporation         Address         By:         Duly Authorized Official
Notary Public Commission expiration date Seal:	Name of Corporation         Address         By:

\*\*\*END OF SECTION\*\*\*

## SECTION 16260

# AUTOMATIC TRANSFER SWITCHES

# PART 1--GENERAL

#### 1.01 DESCRIPTION

This section specifies automatic transfer switches (ATS) rated 600 volts and less for lighting, HVAC, and motor loads with rating as indicated on the drawings.

The ATS shall use electrically-operated, mechanically-held, power rated, electrical contactors to provide double throw switching action with number of poles as shown or specified.

Refer to the standby engine-generator interface and interlock requirements in Section 16231.

# 1.02 QUALITY ASSURANCE

#### A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE Standard 446	Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

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Reference	Title
NEC Article 701 and 702	National Electrical Code: Legally Required or Optional Standby Systems
NFPA 70 - NEC	National Fire Protection Association 70 - National Electric Code
NEMA ICS 6	Enclosures for Industrial Controls and Systems
NEMA Standard ICS10	AC Automatic Transfer Switches
NFPA 110	Emergency and Standby Power Systems
UL 508	Industrial Control Equipment
UL 1008	Standard for Automatic Transfer Switches

# B. LISTING:

The ATS shall be Underwriters Laboratory listed in accordance with UL 1008 and for use as standby system use.

# C. FACTORY TEST:

The ATS shall be factory tested to ensure proper operation.

#### 1.03 SUBMITTALS

The following submittals shall be provided in accordance with Section 101:

#### A. SHOP DRAWINGS:

A copy of this specification section, with addendum updates included, 1. paragraphs 16000-1.05 A and D, and all referenced and applicable sections, with addendum updates included, with each paragraph checkmarked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any

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requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

- A copy of the contract document electrical 2E-1 through 2E-3 (Well), 3E-1 through 3E-3 (PS 0), 4E-1 through 4E-3 (PS 1), 5E-1 through 5E-3 (PS 2), and 6E-1 through 6E-3 (PS 3), with addendum updates included, marked to show deviations. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
- 3. Arrangement drawings of the transfer switch enclosure indicating the front door and interior panel equipment arrangement and dimensions.
- 4. List of materials and components shall accompany the arrangement drawing.
- 5. Elementary and internal connection diagrams.
- 6. Manufacturers' data marked to indicate momentary, interrupting, and continuous current ratings of all relevant equipment, components, and devices.

# PART 2--PRODUCTS

# 2.01 MANUFACTURERS

The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include:

- 1. GE-Zenith.
- 2. ASCO Power Technologies.
- 3. Caterpillar.

# 2.02 RATING

The voltage, current, frequency and number of poles shall be as specified and shown. The ATS shall be rated 480 Vac and rated to close onto and withstand a fault, with the Withstand Closing Rating (WCR) of 65,000 symmetrical amperes.

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2.03 ENCLOSURE

A. Well: NEMA 4, pad-lockable. Pump Stations: NEMA 3R (subject to washdown), pad-lockable.

B. Manufacturer standard finish.

C. Structural bracing of the assembly by the Manufacturer per the requirements of paragraph 16000-1.05 D.

# 2.04 CONTROL AND MONITORING

The switch shall contain the following devices in the control circuit:

- 1. Voltage pickup relay, adjustable 85 to 100 percent.
- 2. Frequency pickup relay, adjustable 90 to 100 percent.
- 3. Time delay relay for open transition from normal to emergency (TDNE): adjustable from 0.2 to 50 seconds.
- 4. Time delay relay for open transition from emergency to normal (TDEN): adjustable from 0 to 30 minutes.
- 5. Time delay for open position transition to allow motor load EMF decay: adjustable from 1 to 10 second.
- 6. Engine cool-down timer: 0-60 minutes.
- 7. ATS transfer test switch mounted on equipment cover or door.
- 8. Switch position indicating lights: Green light for normal source and red light for standby source.
- 9. Generator start command: output relay.
- 10. Engine Generator Exerciser: Adjustable exerciser with load transfer, start time, duration, retransfer, and cool-down time.
- 11. Monitoring: Event logging with data, time, and reason.
- 12. Output status and alarm contacts:

- a. Normal Position (1-set Form-C).
- b. Standby Position (1-set Form-C).
- c. ATS Trouble (1-set Form-C).

## 2.05 TERMINATIONS

Arrange internal equipment items for power cable bottom entry and bottom exit.

Provide oversized termination lugs as required for the size and quantity of conductors shown. Provide copper bus, terminations and connections.

# 2.06 NAMEPLATES

The switch shall be identified as indicated on the drawings and nameplates shall be provided in accordance with the requirements of Section 16000. Provide black nameplates with white lettering.

# 2.07 PRODUCT DATA

The following information shall be provided in accordance with Section 101:

- 1. Operation and maintenance information specified including:
  - a. Final reviewed submittal.
  - b. ATS final configuration settings.

# PART 3--EXECUTION

#### 3.01 GENERAL

Standby Systems shall conform to NFPA-70: NEC Article 702 requirements for installation, wiring, grounding, and signage.

#### A. WIRING:

The control and monitoring wiring shall be installed as shown.

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#### 3.02 NAMEPLATES

# Provide black nameplate with white lettering on the Main Disconnect Switch access door: "AUTOMATIC TRANSFER SWITCH LOCATED ONSITE / 480 VAC POWER ALSO FROM STANDBY GENERATOR LOCATED OUTSIDE OF THIS BUILDING".

#### 3.02 FIELD ADJUSTMENTS

The time delay relays shall be adjusted to the following values:

1.	Voltage pickup:	90 percent
2.	Frequency pickup:	95 percent
3.	Normal to emergency time delay:	5 minutes
4.	Emergency to normal time delay:	20 minutes
5.	Open Position time delay:	5 seconds
6.	Engine cool-down delay:	30 minutes

Field settings shall be recorded and provided with O&M data.

#### 3.03 FIELD TESTS

The following tests shall be performed on the equipment provided under this section. Tests shall be in accordance with the latest version of UL and NEMA standards.

- 1. Electrical insulation check to verify the integrity and continuity of the system.
- 2. Visual inspection to ensure that the switch matches the specification requirements and to verify fit and finish meet quality standards.
- 3. Mechanical tests to verify that the switch's power sections are free of mechanical hindrances.
- 4. Test the ATS using engine-generator set per Section 16231.

#### 3.04 EXERCISE

Configure the ATS for scheduled operation in accordance with Owner test schedule, and demonstrate transfer switch, generator, and pump operation on standby power. Request schedule information in-advance:

Example: Wednesday at 10 AM, the well pump load transfers from the Power Utility to the GenSet in accordance with the following to verify that the genset and transfer scheme is operational. Provide settings for the

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automatic test using the ATS transfer timer schedule. Site load for 2 hours on generator, then retransfer to Power Utility.

\*\*END OF SECTION\*\*

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## SECTION 16431

# ARC FLASH ANALYSIS, SHORT CIRCUIT STUDY, AND PROTECTIVE DEVICE COORDINATION REPORT

### PART 1--GENERAL

#### 1.01 DESCRIPTION

### A. GENERAL:

This section specifies that the Contractor subcontract an independent full member NETA Engineering and Study Firm / Testing Firm to prepare:

- 1. Electrical equipment short circuit study (SCS).
- 2. Protective device coordination study (PDCS) report.
- 3. Arc flash analysis (AFA) and labeling.

#### B. SCHEDULE:

Provide study, report, and labeling for all equipment at the following sites:

- 1. Leupp Well.
- 2. Pump Station 0.
- 3. Pump Station 1.
- 4. Pump Station 2.
- 5. Pump Station 3.
- 6. Dilkon Tank Site.
- C. SCOPE:

The Short Circuit and Protective Device Coordination Report shall include analysis including Utility Company equipment that affect the installed equipment's short circuit ratings, protective device ratings and protective device settings.

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Report shall also include analysis of the equipment's short circuit ratings, protective device ratings and protective device settings affected by the installed equipment.

Report shall include the results of the arc flash hazard analysis study for energized electrical equipment in accordance with the methods outlined in IEEE Standard 1584 and stated hereinafter.

Work shall include the fabrication of signs with the arc flash hazard study results and the installation of the signs on the equipment in accordance with NFPA 70E Table 3-3.9.3 that includes the personnel protective equipment (PPE) risk category, the energy available, and the clothing recommendation.

#### 1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 141	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
NFPA 70E	Standard for Electrical Safety in the Workplace
NETA ATS	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

## B. QUALIFICATIONS:

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The short circuit and coordination report shall be performed, and signed by the professional electrical engineer (Study Firm) responsible for the studies and registered to practice engineering in the state of Arizona.

### 1.03 SCHEDULE

The report shall be completed, submitted to the Construction Manager for acceptance and reworked to include the Construction Manager comments and corrections, as required. The report shall be approved by the Construction Manager prior to purchase and fabrication of electrical equipment.

A copy of the Construction Manager accepted report shall be sent by the Contractor to all affected manufacturers prior to fabrication.

### 1.04 SUBMITTALS

The report specified in this Section shall be provided in accordance with Section 101.

### PART 2--PRODUCTS

#### 2.01 REPORT

The product shall be a certified report summarizing the short circuit and coordination study and conclusions or recommendations which may affect the integrity of the electric power distribution system. As a minimum, the report shall include the following:

- 1. The equipment manufacturer's information used to prepare the study.
- 2. Power Utility Company system information applicable to the project.
- 3. Short circuit calculations listing short circuit levels at each bus. Provide a sketch of the bus and use both the project term and the bus-code-name to identify the bus, branches, sources, loads. Base the system on the Project One-Line diagram.
- 4. Coordination study time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.
- 5. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment protecting that bus.

- 6. Data used as input to the report that includes cable impedances, source impedances, equipment ratings for the equipment being purchased for the project, etc.
- 7. Assumptions made during the study.

## PART 3--EXECUTION

## 3.01 GENERAL

Provide a short circuit and coordination study on the electrical power distribution system as specified and as described in Section 6.1 of NETA ATS. The studies shall be performed in accordance with IEEE Standards 141 and 242 and shall utilize the ANSI method of short circuit analysis in accordance with ANSI C37.010.

The studies shall be performed using actual equipment data for new equipment. The coordination study shall use the data from the same manufacturer of protective relay devices as being provided by the switchgear manufacturer.

For new equipment, the Contractor shall provide copies of final reviewed equipment submittals upon request by the Study Firm.

The Study Firm shall provide one, one man-day trip of onsite investigation to identify loads and power distribution equipment data.

Any power distribution equipment outages shall be scheduled in advance and coordinated with the Owner to limit water service outages.

## 3.02 NOT USED

#### 3.03 SHORT CIRCUIT STUDY

The Contractor shall be responsible to obtain and verify all data needed to perform the study. As a minimum, the short circuit study shall include the following:

- A. One-Line Diagram:
  - 1. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
  - 2. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.

- 3. Power, voltage ratings, impedance, primary and secondary connections of all transformers.
- 4. Type, manufacturer, and ratio of all instrument transformers energizing each relay.
- 5. Nameplate ratings of all motors and generators with their subtransient reactances. Transient reactances of synchronous motors and generators and synchronous reactances of all generators.
- 6. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors.
- 7. Significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
- 8. Emergency as well as normal switching conditions, as applicable.
- 9. The time-current setting of existing adjustable relays and direct-acting trips, as applicable.
- B. Impedance Diagram:
  - 1. Available MVA, voltage, and impedance from the power utility company.
  - 2. Local generated capacity impedance.
  - 3. Bus impedance.
  - 4. Transformer and/or reactor impedances.
  - 5. Cable impedances.
  - 6. Equipment impedances.
  - 7. System voltages.
  - 8. Grounding scheme for the project: resistance grounding, solid grounding, or no grounding.
- C. Calculations:
  - 1. Determine the paths and situations where short circuit currents are the greatest.

- 2. Study shall address bolted faults and calculate the 3-phase and line-toground short circuits of each case.
- 3. Calculate the maximum and minimum fault currents.

## 3.04 ARC FLASH ANALYSIS

The Contractor shall be responsible to obtain and verify all data needed to perform the study. The arc flash analysis study shall include the following IEEE Standard 1584 nine step analysis process:

- 1. Collect system and installation data.
- 2. Determine modes of operation.
- 3. Determine bolted fault current.
- 4. Determine arc fault current.
- 5. Determine protective device characteristic and arc fault duration.
- 6. Document system voltages and equipment class.
- 7. Select working distances.
- 8. Calculate incident energy.
- 9. Calculate the arc flash protection boundary.

## 3.05 PROTECTIVE DEVICE COORDINATION STUDY

As a minimum, the coordination study for the power distribution system shall include the following on 5-cycle, log-log graph paper:

- 1. Time-current for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the tap and time dial settings shall be specified.
- 2. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the Construction Manager shall be notified as to the cause.

- 3. Time-current curves and points for cable and equipment damage.
- 4. Circuit interrupting device operating and interrupting times.
- 5. Indicate maximum fault values on the graph.
- 6. Sketch of bus and breaker arrangement.

## 3.06 IMPLEMENTING PDCS SETTINGS

The Study Firm or Contractor shall implement the protective device coordination study settings on new equipment as required in Section 16030, based on the Engineers accepted Protective Device Coordination Report specified herein and submit a final amended report of the Record As-Built electrical equipment protective device settings subsequent to start-up and testing.

## 3.07 ARC FLASH SIGN INSTALLATION

The Study Firm shall work with the Contractor for implementing the Arc Flash Hazard sign installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection and NFPA 70E.

## \*\*END OF SECTION\*\*

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Arc Flash Analysis

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## SECTION 17000

# GENERAL REQUIREMENTS FOR INSTRUMENTATION AND CONTROL

#### PART 1--GENERAL

#### 1.01 DESCRIPTION

#### A. SCOPE:

This section specifies general requirements which are applicable to providing a complete, functional process control, instrumentation, communication, and telemetry systems and modifications for additions to the Leupp-Dilkon water system. The requirements of this section are applicable to all work specified in Division 17 of these specifications.

1. Schedule and coordinate work to minimize water system control outages.

2. Electrical requirements applicable to this work include those specified in Section 16000 for general electrical requirements.

#### B. DESCRIPTION OF WORK:

- 1. Provide Leupp Well. Provide controls and telemetry.
- 2. Provide Pump Station 0. Provide controls and telemetry.
- 3. Provide Pump Station 1. Provide controls and telemetry.
- 4. Provide Pump Station 2. Provide controls and telemetry.
- 5. Provide Pump Station 3. Provide controls and telemetry.
- 6. Provide controls at existing Tolani Lake Tower, connect to existing Microwave system.
- 7. Provide controls at existing Dilkon Tower, connect to existing Microwave system.
- 8. Provide electrical and controls at Dilkon Tank Site. Restore telemetry communications with existing Dilkon Pass Tank.

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- 9. Provide telemetry units per details from NTUA Technical Provisions 4.0 for AC Tank Control Panel, PLC Control Panel (Simplex Well), and PLC Control Panel (Booster with BoosterPAQ), as included in the Bid Documents.
- 10. Provide work as specified and per NTUA Standard Drawings and Indian Health Services Navajo Nation Standard Drawings.
- 11. Provide testing per Section 16030 and 17030.
- 12. Programming to be Owner furnished for PLCs and touchscreens. Coordinate work, programmers, and provide testing:
  - a. Leupp Well.
  - b. Pump Station 0.
  - c. Pump Station 1.
  - d. Pump Station 2.
  - e. Pump Station 3.
  - f. Tolani Lake Tower controls and telemetry.
  - g. Dilkon Tower controls and telemetry.
  - h. Dilkon Tank controls and telemetry. Retain existing antenna system, radio, and restore Dilkon Pass Tank communications.
- 13. Programming to be Owner furnished for existing PLCs and touchscreens:
  - a. Existing Dilkon Pass Tank controls and telemetry.
- 14. Equipment to be Owner furnished:
  - a. Only that which is labeled as "EXISTING" on drawings.

15. All replaced or removed items shall be salvaged. Salvaged items shall be properly disconnected to retain their full salvage value and cleaned before turning over to the Owner.

C. DEFINITIONS:

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1. SYSTEMS INTEGRATOR: A firm engaged in the business of detailed control system design and engineering, instrumentation component purchase, system and panel assembly, programming, and implementing the specified process control and industrial automation systems.

## 1.02 QUALITY ASSURANCE

### A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title		
IEEE 100	Standard Dictionary of Electrical and Electronics Terms		
ISA S5.4	Instrument Loop Diagrams		
ISA S20	Specification Forms For Process Measurement and Control Instrumentation, Primary Elements, and Control Valves		
ISA S51.1	Process Instrumentation Terminology		
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations		
NEMA ICS 1	General Standards for Industrial Control and Systems		

#### B. SYSTEMS INTEGRATOR RESPONSIBILITY:

- 1. GENERAL
  - a. The specified control system and instrumentation integration including panel building, instrument calibration, testing, start-up,

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operational testing, and training shall be performed by a Systems Integrator staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.

- b. The control system components shall, as far as practical, be of one manufacturer.
- c. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.
- d. The overall system performance shall be demonstrated to and accepted by Owner.

# 2. SYSTEMS INTEGRATOR QUALIFICATIONS:

- a. The following Systems Integrators are pre-qualified to perform the work specified in Division 17 without the need to provide Evidence of Experience:
  - 1) None.
- b. Contractor-proposed Systems Integrator shall be evaluated based on submittal of the following Evidence of Experience:
  - 1) Submit evidence of experience in performing three similar successful projects in the last five years with one project currently in progress or competed within the last two years.
  - 2) Submit project descriptions with contact names, addresses, and telephone numbers from the project Owner, General Contractor, and Principal Design Firm.
  - 3). Submit organization chart and resumes for proposed project personnel.
  - Submit Training and Certification information.
    Completion of the following training courses or appropriate portions thereof or possession of the following certifications included with the Systems Integrator's personnel experience requirements described above:

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- a) Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.
- b) Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.
- c) Programmer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.
- d) Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program.
- e) Certified training programs, as offered by ISA.
- 5) Submit financial data for Systems Integrator division when subsidiary to a parent corporation. Include two years of financial data.
  - a) Financial Statement.
  - b) Balance Sheet.
  - c) Dun & Bradstreet Report.

# C. PROCESS EQUIPMENT COORDINATION

- 1. Division 17 specified equipment shall be coordinated for proper operation with process equipment specified in other Divisions.
- 2. Equipment shall be integrated, furnished, and installed in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.
- 3. Systems Integrator shall obtain manufacturer's technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for

correct signal interfaces between specified equipment and the control system.

- 4. Systems Integrator shall coordinate with project subcontractors and equipment suppliers.
- 5. Systems Integrator shall provide installation supervision for the duration of the project, a minimum of four man-weeks on-site.
- 6. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Construction Manager for resolution before proceeding.

### 1.03 SUBMITTALS

The following information shall be provided in accordance with and Section 101:

- A. SYSTEMS INTEGRATOR QUALIFICATIONS:
  - 1. Systems Integrator Evidence of Experience per paragraph 17000-1.02 B 3. Acceptable review required prior to any other Division 17 submittal.
- B. SHOP DRAWINGS:
  - 1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each requested deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification for requested deviations from the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

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- 2. A copy of the contract document Drawings Sheets 2-3; 2E-2 and 3 (Well), 3-4; 3-9; 3E-2 and 3 (PS 0), 4-9; 4E-2 and 3 (PS 1), 5-9; 5E-2 and 3 (PS 2), 6-9; 6E-2 and 3 (PS 3), and 7-2; 7E-1 (Tanks), relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
- 3. Nameplate list with material, color, tag number and description as specified herein.
- 4. Catalog cuts of equipment, devices, and materials for products to be provided. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Information shall include installation details/drawings, and electrical connection diagrams. Catalog cuts shall be edited to show only the items, model numbers, and information which apply. Submit catalog cuts for only the following:
  - a. Radio components, and list by location.
  - b. Flood level switch for Pump Stations.
  - c. Instruments and Controls per Paragraph 2.03: Submit separately.

d. Chlorine related instruments and controls per Paragraph 2.03: Submit separately.

## 1.04 ENVIRONMENTAL CONDITIONS

A. GENERAL:

Specified data communication and process control equipment shall suitable for operation in indoor locations and in outdoor locations. Ambient conditions are specified in Section 16000.

## B. CORROSIVE LOCATIONS:

Corrosive locations: Chlorine rooms.

## PART 2--PRODUCTS

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### 2.01 GENERAL

#### A. MATERIALS AND QUALITY:

Equipment material shall be new, free from defects, and industrial-grade, as specified. Each type of instrument, instrument accessory, and device used throughout the work shall be manufactured by one firm, where possible.

Equipment and components shall be as specified on the drawings referenced in Paragraph 1.01 B, and in this Section where not specified on the drawings.

### B. RADIO COMPONENTS:

1. Antenna, directional: Kathrein SCALA TY-900, 10 dB Yagi.

2. Antenna, omni-directional for Tolani Lake Tower and Dilkon Tower: Kathrein SCALA K7515641, 5 db.

- 3. Transmission Line: Times Microwave LMR-400 with type N connectors.
- 4. CommScope Andrews 221213 or 3M 2212 tape kit.
- C. FLOOD LEVEL SWITCH:
  - 1. NEMA 4X, industrial, protective cage, stainless steel float, magnetic coupling, aluminum switch and terminal housing, Form C contacts. Magnetrol FLS.

#### 2.02 NAMEPLATES

Nameplates shall be provided for all field mounted instrument, analyzer, or equipment specified in Division 17. Nameplate lettering shall include the equipment or instrument loop title and the instrument or equipment tag number, where nameplate engraving is not specified or shown. Nameplates shall be machine engraved black phenolic with white 5/32-inch high lettering, as minimum, unless otherwise specified or shown. Nameplate wording may be changed without additional cost or time, if changes are made prior to commencement of engraving.

Nameplates shall be attached to support hardware with a minimum of two self-tapping type 316 stainless steel screws in a readily visible location so the nameplate will remain to identify the service when the device is removed. Field instrument namplates shall be attached with braided stainless steel straps where not stand mounted.

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## SECTION 17030

### PROCESS INSTRUMENTATION AND CONTROL SYSTEM TESTING

#### PART 1--GENERAL

#### 1.01 DESCRIPTION

This section specifies Contractor and Systems Integrator performance in testing and documentation of process instrumentation and control system materials and equipment (PICS). Additional specific testing has been added to Paragraph 3.03 per Navajo Area Indian Health Service – Technical Provisions for Motor Control Center and Tank Control Panel.

The term instrumentation covers field and panel instruments, analyzers, primary sensing elements, transmitters, power supplies, and monitoring devices.

Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein. Coordinate all testing with Section 16030:

- A. Factory Acceptance Testing (FAT)
- B. Pre-Operational Performance Testing Sequence:
  - 1. Telemetry PLC Control Panel
  - 2. Wiring Testing
  - 3. Telemetry Communications
  - 4. Instrumentation Calibration
  - 5. Loop Testing
- C. Functional Testing Sequence:
  - 1. Process Control Strategy Testing
  - 2. Control System Closed Loop Commissioning
  - 3. Functional Checkout

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## D. Operational Testing:

## 1. System Acceptance Testing (SAT)

#### 1.02 QUALITY ASSURANCE

#### A. REFERENCES:

This section contains references to the following documents with additional references listed in Section 17000. All references shall be to the current edition of the document unless specifically stated otherwise. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no bids). If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the replacement documents is identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Where document dates are given in the following listing, reference to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ISA S51.1	Process Instrumentation Terminology

#### B. PROJECT LABELING

The items specifying project labeling herein shall include the following as a minimum: Owner's name, facility name, project name, and project number.

#### 1.03 SUBMITTALS

Submittal material, to be submitted in accordance with Section 01300, shall consist of the following:

#### A. PRE-TESTING SUBMITTAL:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or

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marked to indicate requested deviations from specification requirements. A <u>check mark</u> shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each requested deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification for requested deviations from the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

- 2. Control descriptions per paragraph 17030-2.02 C.
- 3. I/O Interface Summaries per paragraph 17030-2.02 D.
- 4. Testing status spreadsheets per paragraph 17030-2.02 A. 3.
- 5. Test procedures per paragraph 17030-3.01 D.
- 6. Proposed test forms per PART 3 of this Section 17030, detailed for each test for this project.
- B. FAT:
  - 1. FAT schedule of tests and demonstrations, and location.

## PART 2--PRODUCTS

## 2.01 GENERAL

Provide test forms, documentation, and records as specified in the following paragraphs.

## 2.02 TESTING DOCUMENTATION

- A. NOT USED
- B. NOT USED

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## C. CONTROL DESCRIPTION

Provide a control description outlining operation for each process area's system. The Control Description Specification Section 17900 may be used as a basis.

## D. I/O INTERFACE SUMMARY

Provide I/O spreadsheets for each process area's system. Spreadsheets to include the following for each I/O point:

- 1. Signal number/tag
- 2. Annotation description that may be logically abbreviated and that is subject to approval.
- 3. Complete physical I/O channel designation and addressing or communication I/O register designation.
- 4. True/False status designations for digital I/O.
- 5. Process range; engineering units and any multipliers; and raw signal range count for analog I/O.
- 6. Signals: Fixed point and scaled at the Controller with minimum four significant implied digits of scaling. E.g.: 0 to 1400 at Controller for a pH range of 0 to 14 at Operator Interface.
- 7. Provide Operator Interface scaling to display decimal digits required.

#### 2.03 PRODUCT DATA

Provide the following product data submittal after completion of testing.

The following information shall be provided in accordance with specification Section 01300:

- 1. Completed test forms per PART 3.
- 2. List of factory calibrated items and calibration certificates.
- 3. Record of radio modem readings per PART 3.

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## PART 3—EXECUTION

#### 3.01 GENERAL

### A. GENERAL REQUIREMENTS:

Materials, equipment, and construction included under this specification shall be inspected in accordance with this section and subsequent sections of this division. Testing shall be performed by the Contractor in accordance with this and subsequent sections of this Division.

No required test shall be applied without prior notice to the Construction Manager. Between 60 and 70 days before the commencement of any testing activity, the Contractor shall provide a detailed step-by-step test procedure complete with forms for the recording of test results, testing equipment used, and a place for identification of the individual performing or, if applicable, witnessing the test.

## B. TECHNICIAN QUALIFICATIONS:

Field instruments and analyzers shall be calibrated and set up by a certified instrument technician qualified to calibrate the instrumentation.

Technicians shall be qualified by completion and certification from training courses offered by The Instrumentation, Systems, and Automation Society (ISA), the instrumentation and analyzer manufacturer's training courses, or technician training courses at a recognized trade school that specializes in instrumentation calibration.

## C. TEST EQUIPMENT AND MATERIALS:

Provide test equipment to conduct the specified tests that simulate inputs and read outputs with a rated accuracy at the point of measurement at least three times greater than the component under test.

Test instruments shall have a current calibration sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Certified calibration reports traceable to the National Institute of Standards and Technology shall be included with the final test report.

Provide buffer solutions and reference fluids for tests of analytical equipment.

#### D. FIELD TEST PROCEDURE DOCUMENTATION:

Indian Health Service Leupp-Dilkon Water Supply System 156167 Test procedures submitted for approval within 60 days prior to the start of testing.

Test procedures for each analog and discrete loop in the process control system shall be organized and assembled in separate volumes for each process area. Final test records shall be submitted in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.

Test procedure documentation shall include a detailed, step-by-step description of the required test procedure, panel and terminal block numbers for points of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions.

Test report forms for each loop, including forms for wiring, piping, and individual component tests, shall be included with the test procedure documentation. The actual test results shall be recorded on these forms and a final test report assembled as specified in paragraph 17030-3.05.

Test report forms shall be preprinted and completed to the extent possible prior to commencing testing. Test report forms that document the field test procedures shall include the following information:

- 1. Project name
- 2. Process area associated with the equipment under test.
- 3. Instrument loop description.
- 4. Instrument loop identification number.
- 5. Instrument nameplate data.
- 6. Instrument setup and configuration parameters.
- 7. Time and date of test.
- 8. Inspection checklist and results.
- 9. Reference to applicable test procedure.
- 10. Expected and actual test results for each test point in the loop including programmable controller data table or register values.
- 11. Test equipment used.

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- 12. Space for remarks regarding test procedure or results, unusual or noteworthy observations, etc.
- 13. Name, date, and signature of testing personnel.
- 14. Test witness' name and signature.

#### E. PERFORMANCE DEVIATION TOLERANCES:

Tolerances shall be specified in Division 17. Where tolerances are not specified, refer to the manufacturer's published performance specifications.

Overall accuracy requirements for loops consisting of two or more components shall be the root-summation-square (RSS) of the component accuracy specifications. Tolerances for each required calibration point shall be calculated and recorded on the associated test report form.

#### F. INSTALLED TESTS:

The Contractor's Quality Assurance Manager shall coordinate, manage, and supervise the quality assurance program that includes:

- 1. Testing plan with the sequence for the test work.
- 2. Calibration program for all instruments and analyzers.
- 3. Documentation program that records tests results.
- 4. Performance testing program systems.

Test forms provided shall conform to the requirements of reference forms 17000-A through 17000-M included herein. Additional or detailed forms shall be developed as necessary to suit complex instrumentation. Usage of terms used on test forms shall comply with ISA S51.1.

#### G. WITNESSING:

The Owner reserves the right to observe factory and field instrumentation testing and calibration procedures. The Owner shall be notified prior to testing, as specified herein.

#### 3.02 FACTORY TEST

#### A. FACTORY ACCEPTANCE TEST (FAT):

Indian Health Service Leupp-Dilkon Water Supply System 156167 Process Instrumentation and Control System Testing 17030 - 7 1. GENERAL: Control system equipment shall be subject to a Factory Acceptance Test with the factory acceptance tests and subsequent retests witnessed by the Construction Manager and Owner. Control system panel programmable logic controllers shall be loaded with the PLC software, Operator Interface software and the programming and graphic configuration application software at the control system equipment supplier's factory prior to the FAT.

Equipment, panel instruments, panels, or cabinets shall be inspected with factory testing performed. Provide written notice to the Owner thirty working days before the commencement of the FAT activity and include:

- a. Schedule for the FAT.
- b. Location of the FAT.
- c. Testing equipment used.
- d. Detailed test procedure with forms for the recording of test results.
- e. Sign-off spaces for the individuals performing and witnessing the tests.

2. FACTORY ACCEPTANCE TEST PROCEDURES: Panels provided shall be interlocked or networked as applicable, operated, and checked-out by the equipment supplier prior to the FAT. Submit certification indicating that the panels are ready for the FAT.

The FAT shall include the following:

- a. Visual inspection of equipment, instruments, control panels, and graphic displays.
- b. Validation of each input loop and output loop by simulated signals for analog inputs and by shorting discrete inputs.
- c. Validation shall include:
  - 1) Monitoring state changes on operator interface screens based on the inputs state change.
  - 2) Observation of online PLC programming application software with the associated PLC outputs state change.

- 3) Outputs triggered by operator interface software devices (pushbuttons, sliders, manually-entered values, etc.)
- 4) Calibration and operation of instruments on or in the control panels.
- d. Repair of loops which do not pass validation.
- e. Retest of the FAT at no additional cost.

Panels that pass the FAT may be shipped to the site upon shipping schedule and storage accommodation approval by the Construction Manager.

3.03 PRE-OPERATIONAL PERFORMANCE TESTING

### A. GENERAL REQUIREMENTS:

In general, tests shall be performed in the following order:

### B. TELEMETRY PLC CONTROL PANEL:

Perform the following, witnessed by the Owner and Programmer. Test form 17000-L:

- 1. Review dimensions, component layout, and wiring.
- 2. Examine cabinets and components to determine that specified hardware has been installed.
- 3. Examine wiring and panel assembly against specification requirements for quality of workmanship.
- 4. Inventory all panel parts and appropriate documentation.
- C. WIRING TESTS:

Electrical power and signal cable ring-out and resistance testing. Conducted in accordance with Sections 16000 and 16030. Wiring tests shall not be conducted until cables have been properly terminated, tagged and inspected.

- 1. Power and Control: Per Section 16030.
- 2. Signal: Test form 17000-A.

# D. TELEMETRY COMMUNICATIONS:

Perform the following, witnessed by the Owner and Programmer. Test form 17000-M:

- 1. Examine antenna/cable assembly for quality of workmanship. The cable connection to the antenna shall be sealed with tape, then covered with vulcanizing rubber and sealed with tape.
- 2. Provide laptop PC for radio-modem configuration. After complete radio and transmission system installation, connect specified cable from radio to PC. Perform the following:
  - a. Perform VSWR test. Record reflected power reading and submit as Product Data. The system will not be accepted with a reflected power of > 0.2 watts at 1 watt rated output. Test to performed with radio timeout timer and frequency hopper functions temporarily disabled.
  - b. Record radio system address.
  - c. Verify radio antenna alignment to the other specified radio location.
  - d. Record RSSI readings after antenna alignment is complete. Communications are not to exceed -100 dBm.
  - e. Verify unit is set for master mode if tank site, remote mode for wells. If configured for master, check for long polling (Modbus messaging).
  - f. Verify radio setting Buff = On.
  - g. Verify radio to PLC communication settings:
    - i. Baud Rate = 9600
    - ii. Data Bits = 8
    - iii. Parity = Even
    - iv. Stop Bits = 1
- 3. Transmission line or antenna related fault or trouble conditions shall be investigated and resolved to the satisfaction of the Owner. Replace damaged transmission line or related components, lightning protectors, poles, towers, or connectors that were installed improperly. Re-align antennas as required for maximum signal strength.
- 4. Inventory all panel parts and appropriate documentation.

## E. INSTRUMENTATION CALIBRATION:

1. Instruments and final elements shall be field calibrated in accordance with the manufacturer's recommended procedures and tested in accordance with the Contractor's test procedure.

- 2. Individual Component Calibration and Testing shall not commence until Instruments and Component Inspections are completed and documented to the satisfaction of the Owner.
- 3. Analog instrument calibrated at 0, 10, 50, 90, and 100 percent of the specified full scale range. Each signal sensing trip and process sensing switch shall be adjusted to the required setting. Test data recorded on test forms as specified herein.
- 4. Final element alignment tested and adjusted to verify that each final element operates smoothly over the full range in response to the specified process control signals.
- 5. Test data shall be entered on the applicable test forms at the time of testing. Final elements shall be checked for range, dead-band, and speed of response.
- 6. Any component that fails to meet the required tolerances shall be repaired or replaced by the manufacturer. Repeat the specified tests until the component is within tolerance.
- 7. Install a calibration sticker on each instrument following successful calibration that indicates the date of calibration, the name of the testing company, and personnel who calibrated the instrument.
- 8. Test forms 17000-C through 17000-I.

# F. LOOP TESTING:

- 1. Loop Testing shall not commence until the Individual Component Calibration and Testing has been completed and documented to the satisfaction of the Owner.
- 2. Each instrument loop shall be tested as an integrated system. Check operation from field instruments to transmitter to receiving components to the vendor panel or the Plant Control System Operator Interface Station. Test signals shall be injected at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.
- 3. Testing of loops with an interface to a programmable logic controller shall include verification of the programmable logic controller input/output assignment and verification of operation of the input/output system and processor. Inspect the data table or register in the programmable logic controller memory to verify proper operation.

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- 4. If the output control or monitoring device fails to indicate properly, corrections to the loop circuitry or device shall be made. The test shall be repeated until devices and instruments operate as required.
- 5. Correct loop circuitry and repeat the test until the instruments operate properly.
- 6. Test form 17000-J.

## 3.04 FUNCTIONAL TESTING

- A. PROCESS CONTROL STRATEGY/FUNCTIONAL TESTING:
  - 1. Control Strategy Testing shall not commence until the Loop Testing has been completed and documented to the satisfaction of the Owner.
  - 2. Control Strategy Testing is performed by the Programmer and Contractor and consist of installing and debugging the PLC control logic program, verifying the interface points between the PLCs and field devices and equipment, and exercising the control strategies. Control Strategy Testing will be performed on one PLC at a time.
  - 3. Provide qualified personnel to immediately correct any deficiencies in the Work that may be encountered during Control Strategy Testing. Failure of the Contractor to provide such personnel in a timely manner may prolong the time allotted to complete Control Strategy Testing.

## B. CONTROL SYSTEM CLOSED LOOP TESTING:

- 1. Closed-Loop Commissioning shall not commence until the Control Strategy Testing has been successfully completed and documented to the satisfaction of the Owner.
- 2. Closed-loop commissioning tests, performed as part of the system tests, shall demonstrate stable operation of each loop under operating conditions. Tests shall include adjustment of loop tuning parameters.
- 3. Tuning parameters: gain (or proportional band), integral time constant, and derivative time constant for each control loop, adjusted to provide 1/4-amplitude damping, unless otherwise specified.
- 4. The loop response to a step disturbance shall be provided for each loop. Two graphs shall be made for cascaded control loops, one showing the

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secondary loop response with its set point in manual, and the second showing overall loop response.

## C. FUNCTIONAL CHECKOUT:

Conducted to verify the operation of discrete and hardwired control devices, refer to Section 01660. Exercise the operable devices and energizing the control circuit. Operate control element, alarm device, and interlocks to verify the specified action occurs.

#### 3.05 OPERATIONAL TESTING

System Acceptance Test (SAT) shall be performed after component and subsystem tests have been completed. The test of the completed system shall be performed in full operation and shall demonstrate that all functional requirements of this specification have been met. SAT shall demonstrate the following:

- 1. Each component of the system operates correctly with all other components of the system.
- 2. Analog control loops operate in a stable manner.
- 3. Hard-wired and software equipment interlocks perform correctly.
- 4. Process control sequences perform correctly.
- 5. PLC application program performs monitoring and control functions correctly.
- 6. Operator interface graphics represent the monitoring and control functions correctly.
- 3.06 TEST FORMS

# 17000-G. FIELD SWITCH CALIBRATION TEST DATA FORM

Tag No. and Description:	
Make & Model No.:	Serial No:
Input:	
Range:	
Set Point(s):	

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_

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## 17000-H. TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description:		
Make & Model No.:	Serial No.:	
Input:		
Output:		
Range:	Scale:	

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_

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## 17000-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED

\_\_\_\_\_ Date \_\_\_\_\_ Contractor's Representative

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_

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# 17000-J. INDIVIDUAL LOOP TEST DATA FORM

Loop No.:

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

- Wiring tested: a. (Attach test form 17000-A)
- Not used. b.
- Instruments calibrated: c. (Attach test forms 17000-G through I)
- List step-by-step procedures for testing loop parameters. Test loop with instruments, d. including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Construction Manager's approval.

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_

Owner's Representative

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## 17000-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.:

a.	Loop tested:
	(Attach test form 17000-J)

- b. Controlled or connected equipment tests confirmed:
- Give complete description of loop's interface with process. c.
- With associated equipment and process in operation, demonstrate automatic d. start/stop and control operation.

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_

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# 17000-L. PLC CONTROL PANEL TEST DATA FORM

Location:

### A. PHYSICAL TEST:

List any discrepancies with respect to the panel specifications:

- 1. Dimensions, component layout and wiring specifications.
- 2. Panel and component hardware.
- 3. Quality of Workmanship (wiring and general panel assembly).
- 4. Inventory of all panel parts and documentation (operations and maintenance manual).
- B. FUNCTIONAL TEST:

Discrete Inputs		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

Discrete Outputs				
1				

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2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Analog Inputs	
Loop Powered	
Loop Powered	
Self-Powered	
Self-Powered	

Analog Outputs	
Loop Powered	
Loop Powered	

Po	wer
24 VDC Power	
12 VDC Power	
PS Fail Relay	
GFI	
Radio Power	
Touchscreen	

Comments:

CERTIFIED \_\_\_\_\_ Date \_\_\_\_\_

WITNESSED \_\_\_\_\_ Date \_\_\_\_\_

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## 17000-M. RADIO TEST DATA FORM

Location:

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Radio Model Number:

## A. PHYSICAL TEST:

- 1. Reflected Power:
- 2. Radio System Address: \_\_\_\_\_
- 3. RSSI reading (Remote):
- 4. Mode: \_\_\_\_\_
- 5. Long Polling (Master), Buff = OnData
- 6. Interface Parameters:
  - a. Baud Rate: \_\_\_\_\_
  - a. Data Bits: \_\_\_\_\_
  - a. Parity: \_\_\_\_\_

7. Quality of Workmanship – Antenna/Cable assembly:

CERTIFIED Contractor's Representative		Date	
WITNESSED		Date	
	Owner's Representative	2	
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\*\*END OF SECTION\*\*

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## SECTION 17110

## INSTRUMENT AND CONTROL PANELS

## PART 1--GENERAL

#### 1.01 DESCRIPTION

A. SCOPE:

This section specifies requirements for Telemetry PLC units.

Provide Telemetry PLC units as specified in Paragraph 17000-1.01 B. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label.

Provide telemetry units per details from NTUA Technical Provisions 4.0 for AC Tank Control Panel, PLC Control Panel (Simplex Well), and PLC Control Panel (Booster with BoosterPAQ) drawings. Provide additional signals specified in Paragraph 2.05 I.

B. SUBMITTAL DRAWINGS:

1. GENERAL: The drawings included in the project manual are functional in nature and do not show exact locations of equipment or interconnections between equipment. The Contractor's Systems Integrator shall prepare detailed installation drawings as specified below.

Drawings prepared in AutoDesk AutoCAD, or similar with borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Each revision of a drawing shall include the date and description of the revisions. Drawing prints shall be 11" x 17" with a minimum lettering size of 1/8".

Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with panel wiring and Section 17110, to permit cross-referencing between contract documents and the drawings prepared by the Contractor.

2. CONNECTION DIAGRAMS: Show components of a control panel in an arrangement similar to the actual layout of the panel including internal wiring between devices within the panel. Show terminal blocks used for internal wiring or field wiring, identified as

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such. Indicate insulation color code, signal polarities, and wire numbers and terminal block numbers.

3. INTERCONNECTION DIAGRAMS: Show panels, panel devices, and field devices with wire numbers, cable numbers, raceway numbers, terminal box numbers, terminal block numbers, panel numbers, and field device tag numbers.

4. ELEMENTARY OR SCHEMATIC DIAGRAM: Shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. Provide schematics for internal panel power distribution, lighting, and any panel HVAC.

5. ARRANGEMENT, LAYOUT, OR OUTLINE DRAWINGS: Show the dimensioned external and interior control panel views with components and Bill of Material. Provide panel heat load calculations, and indicate cooling or ventilation provisions as required.

6. NETWORK BLOCK DIAGRAM: A network block diagram is a diagram of the overall SCADA system, with annotated boxes to show the primary network components (controllers, hubs, switches, computers, displays), and annotated interconnecting lines that show the system communication media and communication protocols.

## 1.02 QUALITY ASSURANCE

## A. REFERENCES:

This section contains references to the following documents that are part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title	
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Reference	Title
EIA RS-310C	Racks, Panels, and Associated Equipment
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels

## B. LISTED PRODUCTS:

Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose per Section 16000 or UL recognized.

The control panels shall have factory applied UL 508A labels.

# C. FACTORY TESTING:

Prior to shipment, the manufacturer shall test the functional operation of the control panel as described in the control description Section 17030.

## D. WARRANTY:

In addition to the guarantee specified in the General Conditions, the equipment, components, and assemblies provided shall be warranted against defects in materials and workmanship of a period of 1 year from the date of completion of all testing specified in Section 17030. Provide warranty service when requested. Provide all costs for transportation, labor, and replacement parts associated with a service call required under the warranty. Cost reimbursement will be provided for the service call and any repair work if it is determined that the control system was damaged by vandalism or an Act of God. Cost reimbursement will also be made if the call was due to a non-functioning device which was not part of the Contract installation, or for blown fuses or tripped circuit breakers.

# E. TELEMETRY PLC DRAWINGS:

1. Drawings:

c.

- a. Cover sheet with site name.
- b. Discrete I/O wiring.
  - Analog I/O wiring.

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- d. Power Distribution.
- e. Backplane layout with bill of materials.
- f. Communication cable pinouts.
- g. Nameplate list with material, color, tag number, and description.

## 1.03 SUBMITTALS

Submittals and transmittal procedures for submittals are defined in Section 101. Submit In accordance with the procedures set forth in Section101 that include drawings, information and technical data for equipment and as required in Section 17000. Submittal information shall be included in one complete submittal.

## A. SHOP DRAWINGS:

- 1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owners Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
- 2. A marked copy of specification section 17000.
- A copy of the contract document Electrical Drawings Sheet 2E-2 and 3 (Well), 3E-2 and 3 (PS 0), 4E-2 and 3 (PS 1), 5E-2 and 3 (PS 2), 6E-2 and 3 (PS 3), 7E-1 (Tanks), 10E-1 (Tolani Lake), and 11E-1 (Dilkon Site), relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary

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for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

- 4. A copy of the contract document Instrumentation Drawing Sheet 1-5 relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
- 5. A copy of the contract documentNTUA Technical Provisions 4.0 for AC Tank Control Panel, PLC Control Panel (Simplex Well), and PLC Control Panel (Booster with BoosterPAQ) drawings, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
- 6. Catalog cuts of equipment, devices, and materials for products to be provided. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc. Catalog cuts shall be edited to show only the items, model numbers, and information which apply. Submit catalog cuts for the following:
  - a. Radio components.
  - b. PLC and modules.
  - c. Touchcreen
  - d. Power supplies.
  - e. SCADA Network components
- 7. Manufacturer's installation manual excerpts, as to be used for this project:
  - a. Installation details/drawings.
  - b. Electrical connection diagrams

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- c. Calibration procedures.
- 8. Telemetry PLC drawings and diagrams generated in CAD for the telemetry equipment specified in paragraph 1.02 E. and similar to those included in the drawings.
- 9. List of miscellaneous items, cables, spare and replenishment parts.

## 1.04 ENVIRONMENTAL CONDITIONS

Refer to Section 17000.

## PART 2--PRODUCTS

## 2.01 FABRICATION

A. GENERAL:

Panels shall be designed for the seismic requirements of Section 17000. Structures, equipment, and devices shall be braced to prevent damage from specified forces. Equipment panels shall be capable of operation following a disturbance.

Nameplates with tag number and equipment description shall identify face-mounted instruments. Instruments shall be mounted for access to components and ease of removal. Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear.

Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons. Facemounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel shall be supported underneath at the rear by a 1inch x 1/8-inch thick steel angle.

Panels less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Panels that weigh less than 100 pounds may be wall mounted.

Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.

2.02 PANEL AND COMPONENTS Indian Health Service Leupp-Dilkon Water Supply System 156167

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Equipment material shall be new, free from defects, and industrial-grade, as specified. Each type of equipment, component, accessory, and device used throughout the work shall be manufactured by one firm, where possible.

Equipment and components shall be as specified on the drawings referenced in Paragraph 1.01 A, and in this Section where not specified on the drawings.

#### 2.03 NOT USED

#### 2.04 NAMEPLATES

External door-mounted components and the panel description shall be identified with plastic nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the instrument tag number and description in 3/32-inch minimum size lettering.

The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

The nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA-4X stainless steel panels.

The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

#### 2.05 PANEL FEATURES

A. INTERCONNECTION WIRING:

Panel Interconnecting Wiring:

- 1. Panel control wiring: Single conductor stranded copper NFPA No. 70 Type MTW No. 18 AWG minimum, with an exception for factory supplied PLC wiring harnesses that are U.L. approved.
- 2. Panel instrument wiring: Twisted No. 18 AWG shielded pair or tri conductors.

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- 3. Panel power wiring: Conductors specified in Division 16 and meet the NFPA No. 70 NEC requirements for power including phase, grounded, and grounding conductors.
- 4. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame retardant plastic wiring channels.
- 5. Wiring channels shall comply with UL 94, Type V.
- 6. Wiring channel fill shall not exceed 50 percent.

## B. CONDUCTOR IDENTIFICATION:

Wiring shall be tagged at terminations with machine printed plastic sleeves with three-part wire numbers for instrument and control panel internal conductors:

- 1. Part-1: Prefix of the wire number shall be the instrument loop number or equipment tag number.
- 2. Part-2: Code letter and wire colors per the following tables.
- 3. Part-3: Number that identifies individual circuit conductor Terminal Number.

Code	120 Vac Conductor	Color
L	Power	Black
С	Control	Red
Ν	Neutral	White
PG	Ground	Green

Code	V dc Conductor	Color
PS	24 Vdc Power	Violet
PS	24 Vdc Control	Blue
PS	24 Vdc Common	Brown
S+	Signal (+)	White

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SG	Signal Ground	Black
EG	Equipment Ground	Green
FV	Panel Foreign Voltage	Yellow

## C. CONDUCTOR INSTALLATION AND PROTECTION:

- 1. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.
- 2. Terminal blocks shall be strap screw type rated for 600 volts. Each terminal trip shall have a unique identifying alphanumeric code at one end and a vinyl-marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high.
- 3. No more than two connections shall be made to one terminal.
- 4. Wire connectors shall be locking fork tongue or ring tongue insulated crimp type terminals.
- 5. Terminal blocks shall be;
  - a. Buchanan 0621-1
  - b. Allen-Bradley 1492-HM1 600 V 30-amperes, finger-safe terminal block.
  - c. Allen-Bradley 1492-CD3 600 V 35-amperes with #8 screw terminal block for ring or spade terminals.
  - d. Phoenix Contact or Weidmuller equal products.

## D. FIELD WIRING:

Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel.

## E. FUSE AND FUSE HOLDERS:

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- 1. Fuses for 120 Vac circuits shall have a minimum of 12,000-amperes interrupting capacity and blown fuse indicators.
- 2. Fuses for 24 Vdc circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops.
- 3. Fuses for 24 Vdc circuits shall be 1/2 amp for the power supply to individual instruments.
- 4. Fuse holders shall be tip-out or draw-out type.
- 5. Provide Phoenix Contact or equal products.

# F. CONTROL POWER:

120 Vac control power source: Single power source for all control and DC power.

- 1. Provide direct current power supplies, as required for the load.
- 2. Provide UPS for PLC and derived loop power as specified, as required for the load.

## G. NOT USED

## H. ACCESSORIES:

- 1. Include GFCI convenience receptacle.
- 2. Print pocket.

## I. STANDBY POWER SIGNALS:

Provide the following additional PLC discrete input signals for the Well and Pump Station PLCs:

- 1. Generator Run Status.
- 2. Generator Trouble Alarm.
- 3. Generator Shut Down Alarm.
- 4. Generator Low Fuel or Leak Alarm.

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- 5. ATS Utility Power Position Status.
- 6. ATS Standby Power Position Status.
- 7. ATS Trouble Alarm.

## 2.06 SURGE PROTECTION

Surge protectors shall be as specified on Drawings.

## 2.07 PANEL GROUNDING

- A. Provide as specified on Drawings.
- B. Field analog wiring shields shall only be grounded at the signal ground bar. Test to verify that single ground point at panel signal ground bar.

## 2.08 PANEL DRAWING PROTECTION

Provide wiring diagrams in accordance with Section 01300. Provide a panel-wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

## 2.09 RADIO COMPONENTS

- 1. Radio: Provide GE MDS Trans-NET EL805-MD9X1AFCS0WN, spread-spectrum 928/952 MHz.
- 2. Transmission Line: Times Microwave LMR-300, 3', with type N connectors.

3. Radio to PC configuration cable, GE MDS 03-3246A01. Provide one for the entire system.

## 2.10 SPARE PARTS

The following spare parts shall be provided:

1. Five each of each type and rating of fuse used in the panels.

## 2.12 PRODUCT DATA

The following data shall be provided in accordance with Section 01300:

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- 1. Manufacturer's operation and maintenance information as specified in Section 101, including final reviewed submittal and as-built drawings.
- 2. Test results as specified in Section 17030-Part 2.

## PART 3--EXECUTION

## 3.01 GENERAL

All conduit shall enter the panels from the bottom. Provide Myers hub for ridig steel conduit entry.

Field panels and cabinets shall be mounted in compliance with paragraph 17000-3.01 B.

Provide panels with the As-built schematic, connection, and interconnection diagrams located in a print pocket on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.

## 3.02 NOT USED

## 3.03 PANEL POWER SUPPLY

Power supply and conditioning equipment shall be mounted and connected in compliance with the manufacturer's instructions.

Final raceway connections shall be a flexible conduit in compliance with Division 16.

## 3.04 FACTORY TESTING

The control panel shall be assembled, interconnected, and functionally tested at the assembly shop prior to shipment. The Owner/Engineer shall have the option of witnessing the functional shop test. The Contractor shall notify the Owner/Engineer at least two (2) weeks in advance prior of the scheduled functional shop test.

## 3.05 FIELD TESTING

Field verify the following for Instrument and Control Panels:

1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.

2.	Control contacts installed in the	he ungrounded side of the circuit.
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- 3. Signal and control wiring installed in separate wireways.
- 4. Barriers between the power wiring and the signal and control wiring.
- 5. Connected to the plant grounding system, as specified.
- 6. Center-line of wall-mounted panels shall be 48 inches above the floor.
- 7. Inner door contains a copy of the As-Built elementary and wiring diagrams.
- 8. Inner door contains a protected drawing holder.
- 9. Drawings enclosed in a transparent, protective jacket.
- 10. Functions as specified.
- 11. Mounted with stainless steel unistrut, fittings, and fasteners.
- 12. Tested in accordance with Section 16030 and Section 17030.

\*\*END OF SECTION\*\*

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## SECTION 17900

## CONTROL SPECIFICATIONS

#### PART 1--GENERAL

#### 1.01 DESCRIPTION

A. SCOPE:

This section specifies the control specification strategies for the additions to the Leupp-Dilkon water system that are based on Programmable Logic Controller (PLC) based Telemetry systems.

1. Telemetry System Programming and Touchscreen Graphics Development responsibilities: Refer to Section 17000.

2. The Control Specification strategies describe sequential and interlocking control functions, analog control functions, and color-graphic video display operator interfaces including alarm and event logging. The generic term used herein shall be Telemetry.

3. The Contractor shall provide all necessary labor and equipment to test the control strategies per Section 17030.

B. WATER SYSTEM:

Refer to the General Notes on Sheet 1-5 for a brief overview of the water system. The Telemetry PLCs control tank levels.

## PART 2—PRODUCTS – NOT USED

PART 3--EXECUTION

#### 3.01 STANDARD INTERLOCKS

Interlocks (I) shutdown and prevent equipment from operating:

1. Hardwired interlocks are effective whether the PLC system is in operation or not, and in hand and auto modes unless noted.

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**Control Specifications** 

2. Software interlocks are provided by the PLC, and are usually only effective when the equipment is operating in auto mode unless noted.

The following describe general interlock features for all systems:

## I1 – MOTOR PROTECTION

Equipment motor protection includes overload and/or VFD or RVSS fault or Motor Protection Relay alarm, hardwired only. Manual reset required at the starter, VFD, or RVSS.

## 3.02 STANDARD GENERAL CONTROL STRATEGIES

Control Strategies (CS) define common equipment operations performed by the PLC and displayed by the Telemetry system. Hardwired control strategies are effective for equipment control whether the PLC system is in operation or not, and in hand and auto modes unless noted.

Control Strategies unique to each process system are defined beginning in paragraph 3.03 below. The following describe general control features for all systems:

## CS1 - EQUIPMENT RUN TIME TOTALIZATION

Equipment run time totalization will be calculated and maintained by the PLC based on equipment run status. Totalize in hours from 0 to 9999.

TELEMETRY: Display total in hours.

## CS2 - FLOW TOTALIZATION

Flow totalization will be calculated and maintained by the PLC whenever flow signals exceeds 2-1/2 % of full scale value and analog signal has not failed (refer to CS10). Totalize in gallons times 1,000 (kGal) or gallons times 1,000,000 (MGal) as shown on the P&ID. Totalize from 0 to 9999.

TELEMETRY: Display total in kGal or MGal as shown on P&ID.

Previous 24 hour day flow totalization will also be calculated and maintained by the PLC.

TELEMETRY: Summary display of previous day totals in kGal or MGal as shown on P&ID.

## CS3 - PROCESS ALARM(S), SELF-RESETTING

Process alarms as shown on the P&ID will be determined and maintained by the PLC:

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- 1. Low-Low Alarm: Point value is equal to or less than a predetermined alarm value.
- 2. Low Alarm: Point value is equal to or less than a predetermined alarm value.
- 3. High Alarm: Point value is equal to or greater than a predetermined alarm value.
- 4. High-High Alarm: Point value is equal to or greater than a predetermined alarm value.

An analog point which is in alarm status will not be changed to normal status until the point value changes by the predetermined deadband value for the point, initial setting of 5% of full scale range. PLC alarm setpoints are provided in paragraph 17200-3.03 instrument index.

TELEMETRY: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

CS7 - PROCESS ALARM(S), MANUAL RESET FROM TELEMETRY REQUIRED

Process alarms as shown on the P&ID will be determined and maintained by the PLC:

- 1. Low-Low Alarm: Point value is equal to or less than a predetermined alarm value.
- 2. Low Alarm: Point value is equal to or less than a predetermined alarm value.
- 3. High Alarm: Point value is equal to or greater than a predetermined alarm value.
- 4. High-High Alarm: Point value is equal to or greater than a predetermined alarm value.

An analog point which is in alarm status will not be changed to normal status until reset by the Telemetry Operator and the point value changes by the predetermined deadband value for the point, initial setting of 5% of full scale range. PLC alarm setpoints are provided in paragraph 17900-3.03.

TELEMETRY: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary. Telemetry allows Operator reset of alarms.

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## CS9 - DISCRETE POINT STATUS

The status of each discrete input point will be maintained in the PLC.

The status of each logical discrete point will also be maintained in the PLC. Logical points are points which depend upon the status of one or several discrete input points.

TELEMETRY: Display the status of all discrete and logical discrete status points.

CS10 - ANALOG POINT STATUS

Analog input points will be checked by the PLC for the following status conditions:

Failed: Point value is less than or greater than the specified value range typically less than 3.6 milliamps (mA) and greater than 21.6 mA. Where the PLC module cannot read outside the 4-20 mA range, use discrete alarm bits available from the module or PLC status function block.

TELEMETRY: Display alarm. Display active and cleared-but-unacknowledged alarm in the alarm summary

#### CS11 - GENERAL EQUIPMENT DISCREPANCY

The failure of driven equipment to respond will be monitored by the Telemetry system. Equipment will be considered to be in discrepancy under the following conditions:

- 1. The equipment is in AUTO and the Telemetrysystem attempts to operate the equipment and it does not respond within a defined time period, typically 15 seconds.
- 2. The equipment is in AUTO and running and for whatever reason other than the Telemetry system requesting the equipment to "STOP," the equipment stops.

## CS12 - TELEMETRY INPUTS AND OUTPUTS STATUS

The PLC will monitor status of each individual input, output, and communication module, and all processor statuses available.

TELEMETRY: Display racks with status for each module, using descriptive terms for alarms. Display processor battery status. Display alarms. Display active and cleared-but-unacknowledged alarm in the alarm summary

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**Control Specifications** 

## CS16 - TREND PLOTS

TELEMETRY workstations will graphically plot trends of all process variables (pressure, flow, temperature, level, analytical, electrical kW and Power Factor) in real-time and from historical data. The plant operator will be able to select the plotting interval, within the limits of the actual data collection. Four trends per display view will be possible.

In addition to the plotted data, a trend will include:

- 1. Time
- 2. Date
- 3. Tag number
- 4. Plotting interval
- 5. Time at start
- 6. Time at latest value.
- 7. Range and units

# CS17 – COLOR NOTATION FOR DYNAMIC OBJECTS ON CONTROL GRAPHIC DISPLAY SCREENS

All dynamic objects on control graphic display screens will be provided with multiplecolor display with high performance graphics to identify status as tabulated below. Verify colors with NTUA prior to programming:

Equipment	Status	Required color
Motor	Running	Dark Grey
Motor	Ready or Off	Light Grey (Neutral)
Valve	Opened position	Light Grey
Valve	Closed position	Dark Grey
All	Power on	Light Grey
All	Abnormal condition	Amber (Yellow)
All	Advisory, Control Mode	Blue

## CS18 - DIGITAL ALARM SYSTEM

Alarms as shown on the P&ID will be determined and maintained by the PLC, whether or not specific control strategies are provided. Digital inputs can be from field instruments (level switches, pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and packaged systems (designated terminals with packaged units).

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**Control Specifications** 

TELEMETRY: Display alarms. Display active and cleared-but-unacknowledged alarms in the alarm summary.

#### CS19 - DATA ARCHIVING HISTORIAN AND HISTORICAL FUNCTIONS

None. These are provided by the separate Regional SCADA System.

#### CS20 - DIGITAL STATUS SYSTEM

All digital input status will be displayed on Telemetry screens as required by the reference drawings and specifications regardless whether or not specific control strategies are provided. Each digital input will be shown in its appropriate process screen and/or equipment status screen. Digital inputs can be originated from field instruments (motorized actuators, HVAC related air handling units, power management related contact inputs, level switches, pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and packaged systems (designated terminals with packaged units).

# CS24 - DATA TRANSFER REQUIREMENTS BETWEEN THE PLCs AND THE TELEMETRY SYSTEM

Digital inputs and analog inputs to the Telemetry system and the software logic generated alarms will be displayed or annunciated at the Telemetry touchscreen as specified on the Drawings and in this Section.

The Telemetry system will generate separate alarms if communication is lost with any PLC.

Data displayed on the Telemetry installed on this project will be available to the existing Regional SCADA System.

For the Lower Greasewood Telemetry System, the Regional SCADA System RTU is located at the Lower Greasewood Tank.

For the Ganado Telemetry System, the Regional SCADA System RTU is located at the Ganado Tank.

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**Control Specifications** 

## 3.03 CONTROL STRATEGY – PUMP STATION 0 TANK LEVEL

A. P&ID: Sheet 1-5.

## B. GENERAL DESCRIPTION:

The Pump Station 0 Tank level is maintained by the Leupp Well. The Well has a chlorination system to disinfect the line between the Well and the Tank, especially in the event that any potable water users may be connected to the line.

## C. CONTROL STRATEGY OVERVIEW:

The Leupp Well Telemetry PLC periodically requests the tank level signal from the Pump Station 0 Telemetry PLC via the Tolani Lake Tower Telemetry PLC. Start/stop setpoints for the Well are Operator adjustable at the Leupp Well Telemetry PLC Touchscreen.

The Leupp Well chlorinator runs whenever the well pump runs.

The Leupp Well Telemetry PLC sends Well status and well flowrates to the Pump Station 0 Telemetry PLC via the Tolani Lake Tower Telemetry PLC.

The Leupp Well Telemetry PLC sends Well status and flowrates to SCADA via the Tolani Lake Tower Telemetry PLC.

The Pump Station 0 Telemetry PLC sends Pump Station 0 Tank Level to SCADA via the Tolani Lake Tower Telemetry PLC.

## D. LOCAL CONTROL:

1. Field – Tank 0:

Reservoir Mechanical Level indication

2. Field - Well:

Well Discharge Pressure indication Well Discharge Flow indication

3. Well MCC:

HAND-OFF-AUTO selector switch inside RVSS Panel

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**Control Specifications** 

4. Interlocks per 17900-3.01:

I1 – MOTOR PROTECTION

## E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy, per above and including:

CS1 - EQUIPMENT RUN TIME TOTALIZATION CS2 - FLOW TOTALIZATION CS11 - GENERAL EQUIPMENT DISCREPANCY CS16 - TREND PLOTS

- 2. Software Interlocks per 17900-3.01: None.
- 3. TELEMETRY TANK 0:

Tank Level indication Touchscreen indication of Telemetry from/to the Well

4. TELEMETRY - WELL:

RUN status Soft Start FAULT alarm Soft Start HIGH TEMPERATURE alarm Soft Start OVERCURRENT alarm AUTO status Pump Motor Amps indication Well Level indication Well Level indication Flow and Total indication Well HMI HAND-OFF-AUTO, Hand status Well HMI HAND-OFF-AUTO, Off status Well HMI HAND-OFF-AUTO, Auto status Telemetry Communications Health

6. TELEMETRY – FOR SCADA:

The Telemetry signals above are all available at SCADA.

## 3.04 CONTROL STRATEGY – PUMP STATION 0 CHLORINATION

A. P&ID: Sheet 1-5.

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**Control Specifications** 

B. GENERAL DESCRIPTION:

Pump Station 0 has redundant chlorinators to disinfect the lines from Pump Station 0 through Stations 1, 2, and 3 and to the Dilkon Tanks.

C. CONTROL STRATEGY OVERVIEW:

The Pump Station 0 chlorinator runs whenever the booster pumps run.

The PLC generates a low chlorine residual alarm when the chlorinator is running if residual is low.

The Pump Station 0 Telemetry PLC sends Pump Station 0 Tank Chlorine alarm and status to SCADA via the Tolani Lake Tower Telemetry PLC.

- D. LOCAL CONTROL:
  - 1. Field:

Chlorine Residual indication Chlorine Leak alarm Chlorine Weight indication

3. MCC:

None.

4. Interlocks per 17900-3.01:

None.

## E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy, per above and including:

CS7 - PROCESS ALARM(S), MANUAL RESET REQUIRED

- 2. Software Interlocks per 17900-3.01: None.
- 3. TELEMETRY:

Chlorine Residual indication Chlorine Leak alarm Chlorine Weight indication

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**Control Specifications** 

## 4. TELEMETRY – FOR SCADA:

The Telemetry signals above are all available at SCADA.

## 3.05 CONTROL STRATEGY – PUMP STATION 1 TANK LEVEL

A. P&ID: Sheet 1-5.

B. GENERAL DESCRIPTION:

The Pump Station 1 Tank level is maintained by the Pump Station 0, providing water sourced from the Leupp Well.

C. CONTROL STRATEGY OVERVIEW:

The Pump Station 0 Telemetry PLC periodically requests the tank level signal from the Pump Station 1 Telemetry PLC via the Tolani Lake Tower Telemetry PLC.

The Pump Station 1 Tank level is forwarded from the Pump Station 0 Telemetry PLC to the Pump Management Unit (BoosterPAQ).

Start/stop setpoints for the Pumps are Operator adjustable at the Pump Management Unit Touchscreen. The Pump Management Unit controls pump start/stop and speed to maintain Tank 1 level. Pumps alternate when the duty pump stops.

The Pump Station 0 Telemetry PLC sends pump status and discharge flowrate to the Pump Station 1 Telemetry PLC via the Tolani Lake Tower Telemetry PLC.

The Pump Station 0 Telemetry PLC sends pump status and discharge flowrate to SCADA via the Tolani Lake Tower Telemetry PLC.

The Pump Station 1 Telemetry PLC sends Pump Station 1 Tank Level to SCADA via the Tolani Lake Tower Telemetry PLC.

## D. LOCAL CONTROL:

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1. Field – Tank 1:

Mechanical Level indication

2. Field - Pump Station 0:

Discharge Pressure indication Indian Health Service Leupp-Dilkon Water Supply

**Control Specifications** 

Discharge Flow indication

3. Pumps VFD:

HAND-OFF-AUTO selector Keypad

4. Interlocks per 17900-3.01:

**I1 – MOTOR PROTECTION** 

## E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy, per above and including:

CS1 - EQUIPMENT RUN TIME TOTALIZATION CS2 - FLOW TOTALIZATION CS11 - GENERAL EQUIPMENT DISCREPANCY CS16 - TREND PLOTS CS51 – ALTERNATION

- 2. Software Interlocks per 17900-3.01: None.
- 3. TELEMETRY TANK 1:

Tank Level indication Touchscreen indication of Telemetry from Pump Station 0

4. TELEMETRY – PUMP STATION 0:

RUN status VFD FAULT alarm VFD HIGH TEMPERATURE alarm VFD OVERCURRENT alarm AUTO status Pump Motor Amps indication Flow and Total indication Telemetry Communications Health

5. TELEMETRY – FOR SCADA:

The Telemetry signals above are all available at SCADA.

## 3.06 CONTROL STRATEGY – PUMP STATION 2 TANK LEVEL

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Control Specifications

A. P&ID: Sheet 1-5.

## B. GENERAL DESCRIPTION:

The Tank level is maintained by Pump Station 1 providing water sourced from the Leupp Well. Operation is the same as for Pump Station 1 Tank above.

## 3.07 CONTROL STRATEGY – PUMP STATION 3 TANK LEVEL

A. P&ID: Sheet 1-5.

## B. GENERAL DESCRIPTION:

The Tank level is maintained by Pump Station 2 providing water sourced from the Leupp Well. Operation is the same as for Pump Station 1 Tank above.

## 3.08 CONTROL STRATEGY – DILKON TANK LEVEL

- A. P&ID: Sheet 1-5.
- B. GENERAL DESCRIPTION:

The Dilkon Tank level is maintained by the Pump Station 3, providing water sourced from the Leupp Well.

## C. CONTROL STRATEGY OVERVIEW:

The Pump Station 3 Telemetry PLC periodically requests the tank level signal from the Dilkon Tank Telemetry PLC via the Dilkon Tower Telemetry PLC.

The Dilkon Tank level is forwarded from the Pump Station 3 Telemetry PLC to the Pump Management Unit (BoosterPAQ).

Start/stop setpoints for the Well are Operator adjustable at the Pump Management Unit Touchscreen. The Pump Management Unit controls pump start/stop and speed to maintain Tank 1 level. Pumps alternate when the duty pump stops.

The Pump Station 3 Telemetry PLC sends pump status and discharge flowrate to the Dilkon Tank Telemetry PLC via the Dilkon Tower Telemetry PLC.

The Pump Station 3 Telemetry PLC sends pump status and discharge flowrate to SCADA via the Dilkon Tower Telemetry PLC.

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**Control Specifications** 

The Dilkon Tank Telemetry PLC sends Tank Level to SCADA via the Dilkon Tower Telemetry PLC.

- D. LOCAL CONTROL:
  - 1. Field Dilkon Tank:

Mechanical Level indication

2. Field - Pump Station 3:

Discharge Pressure indication Discharge Flow indication

3. Pumps VFD:

HAND-OFF-AUTO selector Keypad

4. Interlocks per 17900-3.01:

I1 – MOTOR PROTECTION

#### E. REMOTE OR AUTOMATIC CONTROL:

1. Control Strategy, per above and including:

CS1 - EQUIPMENT RUN TIME TOTALIZATION CS2 - FLOW TOTALIZATION CS11 - GENERAL EQUIPMENT DISCREPANCY CS16 - TREND PLOTS CS51 – ALTERNATION

- 2. Software Interlocks per 17900-3.01: None.
- 3. TELEMETRY DILKON TANK:

Tank Level indication Touchscreen indication of Telemetry from Pump Station 3

4. TELEMETRY – PUMP STATION 3:

RUN status VFD FAULT alarm Indian Health Service Leupp-Dilkon Water Supply System 156167

**Control Specifications** 

VFD HIGH TEMPERATURE alarm VFD OVERCURRENT alarm AUTO status Pump Motor Amps indication Well Level indication Flow and Total indication

## 5. TELEMETRY – FOR REGIONAL SCADA:

The Telemetry signals above are all available at SCADA.

#### 3.09 CONTROL STRATEGY – TOLANI LAKE TOWER

A. P&ID: Sheet 1-5.

#### B. GENERAL DESCRIPTION:

- 1. The Telemetry PLC forwards telemetry signals to and from the following:
  - a. Leupp Well and Pump Station 0.
  - b. Pump Station 0 and Pump Station 1.
  - c. Pump Station 1 and Pump Station 2.

2. The Telemetry PLC forwards telemetry signals to and from the following via the Dilkon Tower Telemetry PLC and the existing Microwave Link:

a. Pump Station 2 and Pump Station 3.

3. The Telemetry PLC forwards telemetry signals from the following to SCADA:

- a. Leupp Well.
- b. Pump Station 0.
- c. Pump Station 1.
- d. Pump Station 2.

#### 3.10 CONTROL STRATEGY – DILKON TOWER

A. P&ID: Sheet 1-5. Indian Health Service Leupp-Dilkon Water Supply System 156167

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## B. GENERAL DESCRIPTION:

- 1. The Telemetry PLC forwards telemetry signals to and from the following:
  - a. Pump Station 3 and Dilkon Tanks.

2. The Telemetry PLC forwards telemetry signals to and from Tolani Lake Tower Telemetry PLC and the existing Microwave Link, refer to strategy above.

3. The Telemetry PLC forwards telemetry signals from the following to SCADA:

a. Pump Station 3.

b. Dilkon Tanks.

## \*\*END OF SECTION\*\*

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**Control Specifications** 

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