Navajo Area Indian Health Service

Technical Provisions for Motor Control Center and Tank Control Panel

Version 3
## MOTOR CONTROL CENTER AND TANK CONTROL PANEL

### TECHNICAL PROVISIONS

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TP 1.0 General Information

These Technical Provisions set forth the minimum requirements for fabricating and installing a radio telemetry operated motor control system for the water system. The water system is located (see attached map). Items required by these specifications shall be installed at the pumphouse(s) and tank(s) as noted on the attached map. One hundred twenty (120) volts is (is not) available at the tank site(s).

Under these Technical Provisions the Contracting Officer’s Representative (COR) is a representative of the Indian Health Service’s Office of Environmental Health and Engineering. The Contractor is the person or persons, partnership, firm, or corporation who enters into the contract awarded by the Navajo Engineering and Construction Authority (NECA). The Programmer is a representative of the Navajo Tribal Utility Authority (NTUA) who is responsible for programming the control system.

Although these Technical Provisions require the installation of certain components, it shall be the Contractor’s responsibility to build and install a complete and operational motor control center (MCC), tank control panel and radio control system using the required components. In addition, the Contractor shall provide the COR with the operation and maintenance manuals as described in TP 2.2. Payment shall be made after performance of the system is tested as described in TP 1.6. Upon completion of the installation, the Programmer shall complete all software programming required for motor control operation.

The MCC consists of two primary components: the programmable logic controller (PLC) panel and motor starter panel. The PLC controller panel controls the various motor starter configurations and houses a radio transciever. The motor starter panel shall vary only with respect to motor rating and whether one or two motors are installed for the specific application.

Depending on the availability of AC power at the tank site, the tank control panel shall be either an AC tank panel or a solar tank panel design. The two tank panels differ only with respect to available power. The tank panel also houses a radio transciever.

The radio transcievers shall either be an MDS spread spectrum radio or an MDS 380-512 MHz licensed radio. The COR shall test the MDS spread spectrum radio signal and/or the MDS 380-512 MHz radio signal beforehand to determine the required radio type.

The MCC and radio control system shall be operate in the following manner:

Tank Site

1. An Ametek pressure transducer shall be installed in a transducer vault to measure the tank water level. The transducer shall provide a 4 to 20 mA loop current output proportional to the tank level.
2. A Koyo PLC tank control panel shall be installed on a dedicated stanchion mount.
The PLC panel shall convert the 4-20 mA transducer loop current signal to a numeric decimal value equivalent to the tank level.

3. A MDS radio (spread spectrum or 380-512 MHz) with a station type 10 dB directional antenna shall be installed to transmit and receive data between the tank and pumphouse. The radio and lightning arrestor (polyphase) shall be installed in the panel.

Pumphouse Site

1. A MDS radio (spread spectrum or 380-512 MHz) with a station type 10 dB directional antenna shall be installed to transmit and receive data between the pumphouse and tank. The radio and lightning arrestor (polyphase) shall be installed in the PLC panel.

2. A Koyo PLC control panel with a graphical operator interface terminal (OIT) shall be installed to provide all motor control functions and to convert all input signals to digital data. The pumphouse PLC shall query the tank panel PLC for data at predetermined intervals. The OIT shall provide the operator with information concerning tank level, motor run time, motor impulse count, motor control settings, motor alarms, etc. The OIT shall record alarm history and provide the operator with some control functions, such as, changing tank level set points, changing well level set points, entering up to five operator defined time clock start and stop time settings, etc.

3. The starter panel includes starter(s) (magnetic or soft starter), fused disconnect(s), overload heater(s), phase monitor(s), voltage monitor(s), and an emergency H-O-A switch to operate each starter manually in the event of a PLC or OIT failure.

TP 1.1 COR Responsibilities

In order to provide a smooth installation of the control system, the COR shall accomplish the following:

AC or Solar Tank Site

1. Provide and install an Ametek Model 88C pressure transducer as well as the associated plumbing. Note: The COR shall measure the differential elevation and order the transducer factory-calibrated as described in TP 7.5 Transducer Form.

2. Provide and install the stanchion mount and the labor to dig all necessary trenches between the stanchion mount and the pressure-sensing vault and access hole for wiring to enter the sensing vault.

3. Place one copy of the O&M Manual received from the Contractor in the tank panel enclosure.

4. If applicable, provide NTUA with the following information to be submitted with the FCC license application.
   A. Transmitting station geographic location (i.e. community, county, state).
   B. Latitude and longitude of transmitting site in NAD 83 datum (degrees, minutes, and seconds).
   C. Ground elevation at transmitting site in meters.
   D. Type of supporting structure (i.e. building, tower, water tank, etc.)
   E. Height of supporting structure in meters.

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F. Overall height of structure in meters.
G. Transmitting antenna azimuth in degrees.

Pumphouse Site

1. Provide the labor to dig all necessary trenches between the service pole and the pumphouse and the pitless unit and the pumphouse.
2. Provide the labor and equipment to drill the necessary holes in the pumphouse walls for the power and telemetry conduit entrances.

**TP 1.2 Contractor Responsibilities**

The Contractor shall accomplish the following:

AC Tank Site

1. Mount the AC tank panel on the stanchion mount.
2. Provide and install all necessary conduit for the electrical, control, and antenna cables, and also string all necessary wiring within the conduit.
3. Provide 120 VAC power to the AC tank panel from the load center using number 12 TW solid copper wire.
4. Provide and install 2-inch G.I. pipe or appropriate support equipment for the antenna.
5. Provide and install a Scala Yagi, TY-900, 10 dB antenna including mounts on the antenna mast.
6. Provide and install all necessary wiring from the pressure transducer to the tank panel. The transducer cable shall be American 22 gauge shielded with drain.
7. Provide and install Times Microwave, LMR-400, Coax antenna cable.
8. Provide and install an electrical service pole complete with meter base, weatherhead, disconnect, proper ground and lightning protection.
9. Provide the COR with legible “redlined” as-built drawing showing changes made.
10. Administer performance test.

Solar Tank Site

1. Mount the solar tank panel on the stanchion mount.
2. Provide and install all necessary conduit for the electrical (solar), control, and antenna cables, and also string all necessary wiring within the conduit.
3. Provide and install two batteries in series as specified under TP 4.2 Panel Materials and Components.
4. Provide and install two solar panels in series as specified under TP 4.2 Panel Materials and Components.
5. Provide and install all necessary wiring from the pressure transducer to the tank panel. The transducer cable shall be American 22 gauge shielded with drain.
6. Provide and install a Scala Yagi, TY-900, 10 dB antenna including mounts on the antenna mast.
7. Provide and install in the pressure sensing vault a mount with a wooden shelf on which to set the batteries.
8. Provide and install Times Microwave, LMR-400, Coax antenna cable.
9. Provide and install 2-inch G.I. pipe or appropriate support equipment for the antenna.
10. Provide and install Number 12 AWG THHN stranded wire, with ground, power cable from the solar panels to the solar tank panel.
11. Provide the COR with legible “redlined” as-built drawing showing changes made.

Pumphouse Site

1. Provide and install PLC control panel and starter panel.
2. Provide and install conduit between control panel and gutter tray using rigid conduit.
3. Terminate antenna conduit to the PLC control panel.
4. Provide and install an electrical service pole complete with meter base, weatherhead, disconnect, proper ground and lightning protection as specified per T.P. 8.0.
5. Provide and install all chemical and control room wiring and appurtenances specified under TP 8.0.
6. Provide and install a Scala Yagi, TY-900, 10 dB antenna including mounts on the antenna mast.
7. Terminate antenna cable to lightning arrester (polyphaser).
8. Terminate 120 VAC power circuit for each panel.
9. Terminate any PLC control panel to/from starter panel interface wiring required.
10. Terminate motor leads to motor starter.
11. Provide the COR with legible “redlined” as-built drawing showing changes made.

TP 1.3 Programmer Responsibilities

The Programmer shall accomplish the following:

AC Tank Site

1. Witness performance test
2. Program PLC

Solar Tank Site

1. Witness performance test
2. Program PLC

Pumphouse Site

1. Witness performance test
2. Program PLC, OIT and configure Square D Altistart 48 (3 phase)

TP 1.4 FCC License

If a 380-512 MHz radio is deemed necessary by the COR, an application for a Federal Communications Commission (FCC) license is required. Coordination concerning
frequencies and licensing of the radio system with the FCC is performed by the NTUA. The contact for application processing is:

Darrell Benally  
Navajo Tribal Utility Authority  
P.O. Box 170  
Fort Defiance, Arizona 86504  
(928) 729-5721

The radio system shall not be put into operation by the Contractor nor accepted for operation by the COR or NTUA until authorization by the FCC is granted. After receiving the FCC license, NTUA shall notify the Contractor and provide the frequency information required for the installation.

**TP 1.5 Record Drawings**

The control panel drawings shall consist of a cover sheet, discrete I/O wiring, analog I/O wiring, power distribution (DC, AC, and grounding), backplane layout and communication cable pinouts. The starter panel drawings shall consist of a cover sheet, a logic wiring diagram and general arrangement layout. Drawing hardcopies and a 3.5" diskette containing all drawings in AutoCad 2000 format shall be included in the operation and maintenance manual. Note: “As-builts” similar in form to the panel drawings provided in Sections TP 3.3, TP 4.3, TP 5.3, TP 6.2, TP 6.3, TP 6.4, and TP 6.5 are acceptable.

**TP 1.6 Performance Test**

A performance test shall be scheduled upon completion of the installation. The test shall be scheduled by the Contractor for a date not less than two weeks in advance and agreed upon by the COR and Programmer. All prior disputes shall be resolved before the performance test is scheduled.

The purpose of this test is to verify that the control panel(s) meet the functional, performance, and interface requirements. Full payment shall be rendered to the Contractor upon successful completion for the subject panel(s). The Contractor shall administer the test in the presence of both the COR and Programmer. The COR and Programmer reserve the right to test any specified function whether or not explicitly stated in these Technical Provisions.

At minimum, the performance test shall include the following:

**Physical Test**

1. Review dimensions, component layout, and wiring against specified drawings.
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. An inventory of all panel parts and appropriate documentation.

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Functional Test

1. Verify all PLC I/Os
   A. Test each point by jumpering the DIs and monitoring the state change from Direct Soft 32 reference data area.
   B. Disable each DO from Direct Soft 32 reference data area and read the proper voltage or continuity change at the I/O terminal strip using a multimeter while changing the DO status.
   C. Read each AI from Direct Soft 32 reference data area while applying a variable 4-20mA signal at the terminal strip. The 12 bit resolution of the corresponding data count shall produce the following results:

<table>
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<th>Input/Output Current (mA)</th>
<th>Register Data Count (Decimal)</th>
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<tr>
<td>4.0</td>
<td>0.0</td>
</tr>
<tr>
<td>12.0</td>
<td>2048.0</td>
</tr>
<tr>
<td>20.0</td>
<td>4095.0</td>
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</table>

   D. Read each AO at the terminal strip using a multimeter while changing the data count from Direct Soft 32 reference data area. Again the data count shall produce the output current equivalent to the table from item C above.

2. Verify that proper AC and DC voltages are supplied to each panel device and I/O group and that each panel has an independent ground wired to the load center.

3. Verify radio and antenna/cable functions.

MDS 9810 Model

A. Perform an SWR test. Record reflected power reading. The system shall not be accepted with a value of >0.2 Watts. Note: This test should be performed before the antenna system is secured (deactivate timer and hopper for this test).
B. Record radio system address
C. Record RSSI readings (remote)
D. Check the radio mode (master or remote)
E. Check the master for long polling (Modbus messaging)
F. Check the radio for buff = on
G. Check the radio for data interface parameters:
   - baud rate = 1200
   - data bits = 8
   - parity = even
   - stop bits = 1
H. 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 (Andrews tape kit). The other end of the cable shall be secured to the lightning arrester.

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MDS 4710 Model

A. Perform an SWR test. Record reflected power reading. The system shall not be accepted with a value of >0.2 Watts. Note: This test should be performed before the antenna system is secured (deactivate timer and hopper for this test).

B. Record radio system address

C. Record RSSI readings (remote)

D. Check the radio mode (master or remote)

E. Check the master for long polling (Modbus messaging)

F. Check the radio for buff = on

G. Check the radio for data interface parameters:
   - baud rate = 1200
   - data bits = 8
   - parity = even
   - stop bits = 1

H. 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. (Andrews tape kit) The other end of the cable shall be secured to the lightning arrester.

4. Communication from the PLC to OIT
   A. Download Magelis firmware to OIT.
   B. Verify communications from PLC to OIT.

TP 1.7 Warranty

All apparatuses shall be guaranteed against defective materials and workmanship for one year from the date of the performance test certification. The Contractor shall provide warranty service when requested by the COR. The Contractor shall bear all costs for transportation, labor, and replacement parts associated with a service call required under the warranty. The Contractor shall be reimbursed his costs of making a service call to the installation site and any repair work he performs if it is determined the control system was damaged by vandalism or an act of God. The Contractor shall also be reimbursed his costs if he travels on a warranty call and finds the system does not work because of a non-functioning device which was not part of his installation (e.g., a blown fuse, a tripped circuit breaker, etc.).
TP 2.0 General Panel Requirements

TP 2.1 Panel Materials and Components

The Contractor shall utilize all materials and components as specified in the following respective panel material and component listing. These items shall be furnished in strict accordance with the following provisions and as approved by the COR. These items shall be manufactured/fabricated in accordance with the highest standards of workmanship in the industry.

TP 2.2 Operations and Maintenance Manual

Two copies of the operations and maintenance manual shall be provided by the Contractor to the COR for each tank panel and motor control center. At minimum, the manual shall consists of:

1. Overview of the Panel - A summary of how the panel operates and procedures for operation and maintenance.
2. Component list – A listing of manufacturer’s names and part numbers and manufacturer’s cut sheets and/or standard hardware manuals and troubleshooting guides.
3. As-Built panel drawings – Drawing hardcopies plus a 3.5” diskettes containing copies of the drawings shall be submitted as outlines in Section TP 1.5.

TP 2.3 Wiring

All internal wiring shall be minimum 18 AWG stranded plastic covered conductors. All wiring shall be continuous from terminal to terminal without intermediate splices. For ease of maintenance, all wiring shall be color-coded. Refer to Section TP 7.1 for conductor color code.

All incoming power and control wiring shall be terminated on marked terminal strips, and all terminal connections shall be numbered consecutively. Wiring diagrams showing location, identification, and function of each wire shall be developed by the Contractor and submitted as part of the final as-built drawings. Provide computer printed, heat shrink wrapped or tape wrapped wire numbers.

All internal control panel wiring runs, with the exception of ribbon cable connections, shall be enclosed in suitable plastic raceways with snap-on plastic covers of a size to accommodate the wiring run.

Where possible, wires shall be grouped together in easily disassembled bundles for ease of access. Unsightly wiring shall be the basis for rejection of an entire control panel. All analog signal wiring shall be twisted, individually insulated, shielded pairs. All conductor shields shall be firmly attached to a common ground in the control panel. Wiring shall be done in accordance with the best standards of workmanship and materials.

Signal wires used for input or output shall not be run adjacent to 120 VAC power. Inside
the control panel, DC signal conductors shall be physically separated from 120 VAC conductors.

All electrical wiring shall conform to the National Electric Code and to applicable state and local requirements. Any additional costs resulting from any deviation from codes or local requirements shall be born by the Contractor.

TP 2.4 Surge Protection

All panels shall be protected against electromagnetic, electrostatic, and induced transients and currents by proper shielding and grounding. All inputs, outputs, power, and communication circuits shall also employ adequate transient and noise protection. Control panels shall meet ANSI C 37.90-1979 (R1982) IEEE 472-1974 SWC test requirements (or latest revision) to enable operation without damage in an adverse electrical environment.

TP 2.5 Enclosure

All panels shall be rated NEMA 12 for indoor applications and NEMA 4 for outdoor applications. All outdoor panels with AC input power shall be equipped with a GFI duplex receptacle for convenience. All conduit and external wiring shall enter the bottom of the enclosure. All internal or external mounted items shall be permanently attached and shall not alter the NEMA rating of the enclosure. Myer Hub connectors shall be used on all rigid conduit connections. Compression EMT connectors shall be used on all EMT conduit connections. Flex liquid tite connectors shall be used on all flex liquid tite conduit connections. All outdoor panels shall use the rigid conduit connections.

TP 2.6 Site Conditions

Control panels shall be installed indoors and outdoors at pump stations and tanks. Site conditions are:

Transient Voltages:  +/- 20 percent of nominal 120 VAC voltage over 10 second interval. +/- 100 percent of nominal 120 VAC voltage over 10 ms interval.


Frequency Variation:  58 to 62 Hz

Temperature:  -29C to 60C (20°F to 140°F) ambient

Humidity:  0 to 99 percent non-condensing

Potential Contaminants:  chlorine, fluoride

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TP 3.0 AC Tank Panel

TP 3.1 Description of Operation

The function of the control panel at the tank site shall be to monitor the tank level and the transducer health.

The PLC shall be partially pre-wired for all the I/O available. Four of the discrete inputs shall be wired and operate at 24 VDC. The discrete outputs shall not be wired. The analog inputs shall be wired such that the first two inputs are loop-powered and the second two are self-powered loops. The analog outputs shall not be wired.

All of the I/Os shall be surge protected. The analog loops shall utilize suppresser diode protection while the discrete loops shall utilize metal oxide varistors (MOVs). Suppresser diodes shall be used on analog I/Os because of the failure mode for the MOVs. Failed MOVs short to ground and cause current drains on analog circuits, which, in turn, provide false readings to the PLC. The MOV and suppresser diode mounts shall be a compact style that mounts on a DIN rail.

The AC power system shall be protected with a lightning arrester that shall guard against direct hits as well as providing transient protection. A circuit breaker and a ground fault interrupt power outlet shall be provided for convenience. All AC and DC circuits within the panel shall be protected with plug-in fuses. The plug-in fuses provide an LED indication when a fuse has blown.

The system shall utilize a common power ground. Ground terminals shall be provided throughout the panel and shall be jumpered together.

A forced air heater shall be provided. The heater shall be thermostatically controlled and the fan shall operate whenever power is present to circulate air within the enclosure at all times.

Communication with the motor control center shall be accomplished with either a 9810 or a 4710 MDS radio. The MDS 9810 (Spread Spectrum) radio requires an input voltage range of 10.5 - 25.0 VDC and the MDS 4710 (380 - 512 MHz) radio requires an input voltage range of 10.5 - 16.0 VDC. Consequently, a second power supply rated at 15 VDC output shall be supplied. The radio system shall be protected with a lightning arrester.

TP 3.2 Panel Materials and Components

1. PLC
   MFG: Koyo
   Model: Direct Logic, DL-06
2. PLC Analog Input Module
   MFG: Koyo
   Model: F0-04AD-1
3. Radio
   MFG: Microwave Data Systems
   Model: 9810 or
   Model: 4710

4. 24 VDC Power Supply
   MFG: Phoenix Contact
   Model: QUINT-PS-100-240AC/24DC/5

5. I/O Surge Protection - Discrete Inputs, 24 VDC
   MFG: Phoenix Contact
   Model: Termitrab-SLKK5/24DC
   Type: Metal Oxide Varistor

6. I/O Surge Protection - Analog Inputs, 24 VDC
   MFG: Phoenix Contact
   Model: Termitrab-UK5/24DC
   Type: Supressor Diode

7. Power Surge Protection - 120 AC
   MFG: Phoenix Contact
   Model: MT-2PE/5-120AC

8. General Purpose Terminals
   General Purpose panel terminals shall be manufactured by Phoenix Contact. All components are part of the UK5 family. UK5s are used for spares, power distribution, and grounding.
   A. Components:
      MFG: Phoenix Contact
      Model: UK5 N
      USLK5 Ground TS
      D-UK 4/10
      ISSBI 10-6 & IS-K4
      EB 10-6
      FB 10-6
      ATP-UK
      ZB 6, lgs: 1-10, 11-20 etc.
   B. Fuse Plugs (house fuse plugs):
      MFG: Phoenix Contact
      Model: ST-SILED 24-UK 4 for 24 VDC circuits
      Model: ST-SILA 250-UK 4 for 120 VAC circuits
   C. Component bases (house fuse plugs and component plugs):
      MFG: Phoenix Contact
      Model: UK 4-TG

9. AC Power Distribution - Circuit Breaker
   MFG: Square D
   Model: QOU115
   Power: 115 VAC
   Amps: 15

10. AC Power Distribution - Ground Fault Interrupt
    MFG: Hubbell
    Model: GF5252GY
    Power: 120 VAC

TP 3-2

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11. Enclosure
MFG: Saginaw
Model: SCE-30H24DLP
Backplane: SCE-30P24
Size: 30 H x 24 W x 12 D
NEMA: 4

or
Enclosure
MFG: Hoffman
Model: A-30H24DLP
Backplane: A-30P24
Size: 30 H x 24 W x 12 D
NEMA: 4

12. Enclosure Heater
MFG: Hoffman
Watts: 100
Type: Forced Air
Controller: Thermostat
Size: 7 H x 4.24 W x 5.2 D

13. 15 VDC Power Supply
MFG: Phoenix Contact
Model: MINI-PS-100-240AC/10-15DC/2

14. Antenna Lightning Arrester
MFG: Polyphaser
Model: IS-50NX-C2

15. Flexible Antenna Cable in Enclosure (from the radio to lightning arrester)
Type: LMR-300
Connectors: N-Male at both ends
Length: 3.0'

16. 3' PLC to Modem Cable

**TP 3.3 Drawings** The standard drawing set shall include:

1. Cover Sheet
2. Discrete I/O
3. Analog I/O
4. Power Distribution
5. Backplane Layout
6. Communication Cable Pinouts

TP 3-3

August 05
NAVAJO TRIBAL UTILITY AUTHORITY
CONTROL PANEL LAYOUT

AC TANK PANEL
CABLE DIAGRAM: PLC TO WOODM
TP 4.0 Solar Tank Panel

TP4.1 Description of Operation

The function of the solar control panel at the tank site shall be to monitor the tank level, monitor transducer health, and monitor the voltage level of the batteries. This control panel consists of a Koyo, Direct Logic, DL-06 PLC, a spread spectrum radio, and solar/battery power distribution.

The PLC shall be partially pre-wired for all the I/O available. Four of the discrete inputs shall be wired and operate at 24 VDC. The discrete outputs shall not be wired. The analog inputs shall be wired such that the first two inputs are loop-powered, the third are to be a self-powered loop, and the fourth analog inputs are pre-wired to the photovoltaic controller to measure battery voltage. The battery power monitoring circuit shall be accomplished via a voltage divider network. The analog outputs shall not be wired.

All of the I/Os shall be protected with lightning arrestors. The analog loops shall utilize suppresser diode protection while the discrete loops shall utilize metal oxide varistors (MOVs). Suppresser diodes shall be used on analog I/Os because of the failure mode for the MOVs. Failed MOVs short to ground and cause current drains on analog circuits, which, in turn, provide false readings to the PLC. The MOV and suppresser diode mounts shall be a compact style that mounts on a DIN rail.

The system operates at 24 VDC and the power source shall be a solar array with batteries. Two batteries shall be installed in series to provide a 24 VDC backup voltage. The photovoltaic controller shall be installed in the control panel. This device shall be pre-wired to terminal strips. Consequently, all field terminations shall be located at the terminal strip. All DC circuits shall be protected with plug-in fuses. The plug-in fuses provide an LED indication when a fuse has blown.

The system shall utilize a common ground. Ground terminals shall be provided throughout the panel and shall be jumpered together.

Communications with a motor control center shall be accomplished with a 9810 MDS radio. The MDS 9810 (Spread Spectrum) radio requires an input voltage range of 10.5 - 25.0 VDC. Consequently, a DC/DC converter shall be provided which converts the system power to 15 VDC. The radio system shall be protected with a lightning arrester.

TP 4.2 Panel Materials and Components

1. PLC
   MFG: Koyo
   Model: Direct Logic, DL-06
2. PLC Analog Input Module
   MFG: Koyo
   Model: F0-04AD-1
3. Radio
   MFG: Microwave Data Systems
   Model: 9810
4. Photovoltaic System Controller
   MFG: Morningstar
   Model: ProStar-20 with LCD meter
   PV Current: 20A
   Load Current: 16A
   System Voltage: 12 and 24 volts, auto selected

5. I/O Surge Protection - Discrete Inputs, 24 VDC
   MFG: Phoenix Contact
   Model: Termitrab-SLKK5/24DC
   Type: Metal Oxide Varistor

6. I/O Surge Protection - Analog Inputs, 24 VDC
   MFG: Phoenix Contact
   Model: Termitrab-UK5/24DC
   Type: Suppresser Diode

7. General Purpose Terminals
   General purpose panel terminals shall be manufactured by Phoenix Contact. All
   components are part of the UK5 family. UK5s are used for spares, power
   distribution, and grounding.
   A. Components:
      MFG: Phoenix Contact
      Model:
      UK5 N
      USLKG5 Ground TS
      D-UK 4/10
      ISSBI 10-6 & IS-K4
      EB 10-6
      FB 10-6
      ATP-UK
      ZB 6, lgs: 1-10, 11-20 etc.
   B. Component Plugs (house resistors):
      MFG: Phoenix Contact
      Model: ST-BE
   C. Fuse Plugs (house fuse):
      MFG: Phoenix Contact
      Model: ST-SILED 24-UK 4 for 24 VDC circuits
   D. Component bases (house fuse plugs and component plugs):
      MFG: Phoenix Contact
      Model: UK 4-TG

8. Enclosure
   MFG: Saginaw
   Model: SCE-30H24DLP
   Backplane: SCE-30P24
   Size: 30 H x 24 W x 12 D
   NEMA: 4
   or
   Enclosure
   MFG: Hoffman
   Model: A-30H24DLP
   Backplane: A-30P24
   Size: 30 H x 24 W x 12 D

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9. 24 VDC/12 VDC Converter
   MFG: Calex
   Model: 24S15.2000MHW
   Input Voltage: 17 - 40 VDC
   Output Voltage: 15 VDC
   Output Current: 2000 mA
   Power: 30 Watt

10. Mounting Kit for 24 VDC/12 VDC Converter
    MFG: Calex
    Model: MS8
    Fuse: 1.5 Amp

11. Antenna Lightning Arrester
    MFG: Polyphaser
    Model: IS-50PX-C2

12. Flexible Antenna Cable in Enclosure
    Type: LMR-300
    Connectors: N-Male at both ends
    Length: 3.0'

13. Resistors
    Resistance: 1 K ohm
    Rated: 1/2 watt
    Resistance: 5 K ohm
    Rated: 1/2 watt

14. 3' PLC to Modem Cable

15. Solar Panels
    MFG: Seimens
    Model: SM50
    Quantity: 2
    Configuration: 12 V
    Rated Power: 50 Watts
    Rated Current: 3.05 Amps

16. Batteries
    MFG: Johnson Controls
    Model: GC12V100B
    Quantity: 2
    Enclosure: Sealed
    Capacity: 90 Amp Hours

**TP 4.3 Drawings** The standard drawing set shall include:

1. Cover Sheet
2. Discrete I/O
3. Analog I/O
4. Power Distribution
5. Backplane Layout
6. Communication Cable Pinouts

TP 4-3

August 05
NAVAJO TRIBAL UTILITY AUTHORITY
PUMP CONTROL PANEL LAYOUT

SOLAR TANK PANEL
TP 5.0 PLC Control Panel

TP 5.1 Description of Operation

The function of the PLC control panel shall be to provide all motor control functions. The PLC panel shall govern the activities of the motor starter panel with the exception of the hand and off positions of the emergency HOA switch located in the starter panel. An OIT shall allow operators to change the mode of the motor control panel as well as set thresholds and alarm parameters in addition to monitoring system status.

The PLC shall be partially pre-wired for all the I/O available. Sixteen discrete inputs and four discrete outputs shall be wired and operate at 24 VDC. The analog inputs shall be wired such that the first two inputs are loop-powered and the second two are for self-powered loops.

All of the I/Os shall be protected with lightning arresters. The analog loops shall utilize suppresser diode protection while the discrete loops shall utilize metal oxide varistors (MOVs). Suppresser diodes shall be used on analog I/Os because of the failure mode for the MOVs. Failed MOVs short to ground and cause current drains on analog circuits, which, in turn, provide false readings to the PLC. The MOV and suppresser diode mounts shall be a compact style that mounts on a DIN rail.

The power distribution shall be segregated into 120 VAC and 24 VDC. The AC power system shall be protected with a lightning arrester that shall guard against direct hits as well as providing transient protection. A circuit breaker shall be provided for convenience. All AC and DC circuits within the panel shall be protected with plug-in fuses. The plug-in fuses provide an LED indication when a fuse has blown. The DC power supply shall be an adjustable supply that should be set at 24.0 VDC.

The system shall utilize a common power ground. Ground terminals shall be provided throughout the panel and shall be jumpered together.

The communication with the controlling tank shall be accomplished with either a 9810 or a 4710 MDS radio. The MDS 9810 (Spread Spectrum) radio requires an input voltage range of 10.5 - 25.0 VDC and the MDS 4710 (380 - 512 MHz) radio requires an input voltage range of 10.5 - 16.0 VDC. Consequently, a second power supply rated at 15 VDC output shall be supplied. The radio system shall be protected with a lightning arrester.

TP 5.2 Panel Materials and Components

1. PLC
   MFG: Koyo
   Model: Direct Logic, DL-06
2. PLC Analog Input Module
   MFG: Koyo
   Model: F0-04AD-1
3. Operator Interface Terminal (OIT)
   MFG: Square D
Model: XBTF032110
Display: Color
Screen: 5.7"
Operator Input: Touch Screen

4. Radio
MFG: Microwave Data Systems
Model: 9810 or
Model: 4710

5. 24 VDC Power Supply
MFG: Phoenix Contact
Model: QUINT-PS-100-240AC/24DC/5

6. I/O Surge Protection - Discrete Inputs, 24 VDC
MFG: Phoenix Contact
Model: Termitrab-SLKK5/24DC
Type: Metal Oxide Varistor

7. I/O Surge Protection - Analog Inputs & Outputs, 24 VDC
MFG: Phoenix Contact
Model: Termitrab-UK5/24DC
Type: Suppressor Diode

8. Power Surge Protection - 120 AC
MFG: Phoenix Contact
Model: MT-2PE/S-120AC

9. General Purpose Terminals
General purpose panel terminals shall be manufactured by Phoenix Contact. All components are part of the UK5 family. UK5s are used for spares, power distribution, and grounding.

A. Components:
MFG: Phoenix Contact
Model: UK5 N
USLKSG5 Ground TS
D-UK 4/10
FB 10-6
EB 10-6
ATP-UK
ZB 6, lgs: 1-10, 11-20 etc.

B. Fuse Plugs (house fuses):
MFG: Phoenix Contact
Model: ST-SILED 24-UK 4 for 24 VDC circuits
Model: ST-SILA 250-UK 4 for 120 VAC circuits

C. Component bases (house fuse plugs and component plugs):
MFG: Phoenix Contact
Model: UK 4-TG

10. AC Power Distribution - Circuit Breaker
MFG: Square D
Model: QOU115
Power: 115 VAC
Amps: 15

11. Enclosure – Indoor Application

TP 5-2
MFG: Saginaw  
Model: SCE-302410LP  
Backplane: SCE-30P24  
Size: 30 H x 24 W x 10 D  
NEMA: 12

or

Enclosure
MFG: Hoffman  
Model: A-302410LP  
Backplane: A-30P24  
Size: 30 H x 24 W x 10 D  
NEMA: 12

or

Enclosure – Outdoor Application
MFG: Saginaw  
Model: SCE-30H24CLP  
Backplane: SCE-30P24  
Swing-out Panel: A-NADFK  
Size: 30 H x 24 W x 10 D  
NEMA: 4

or

Enclosure
MFG: Hoffman  
Model: A-30H24CLP  
Backplane: A-30P24  
Swing-out Panel A-NADFK  
Size: 30 H x 24 W x 10 D  
NEMA: 4

12 24 VDC/12 VDC Converter  
MFG: Phoenix Contact  
Model: MINI-PS-100-240AC/10-15DC/2

13. Antenna Lightning Arrester  
MFG: Polyphaser  
Model: IS-50NX-C2

14. Flexible Antenna Cable in Enclosure  
Type: LMR-300  
Connectors: N-Male at both ends  
Length: 3.0'

15. 3' PLC to Modem Cable

TP 5.3 **Drawings** The standard drawing set shall include:

1. Cover Sheet  
2. Discrete I/O  
3. Analog I/O  
4. Power Distribution  
5. Backplane Layout  
6. Communication Cable Pinouts
NAVAJO TRIBAL UTILITY AUTHORITY
PUMP CONTROL PANEL LAYOUT

PLC CONTROL PANEL
Input/Output Wiring
for
Simplex Well
with
Magnetic Starter
POWER DISTRIBUTION THIS PAGE REFLECTS "LOGICAL" SCHEMATIC SEE "DC DISTRIBUTION" DRAWING AND "AC DISTRIBUTION" DRAWING FOR POINT TO POINT TERMINATIONS

LEGEND

 Field Terminations
 Panel Wiring

NAVAJO TRIBAL UTILITY AUTHORITY

Sheet 3 of 8
Input/Output Wiring
for
Booster Station
with
Magnetic Starter
POWER DISTRIBUTION THIS PAGE REFLECTS "LOGICAL" SCHEMATIC SEE "DC DISTRIBUTION" DRAWING AND "AC DISTRIBUTION" DRAWING FOR POINT TO POINT TERMINATIONS

LEGEND

Field Terminations
Panel Wiring
Input/Output Wiring
for
Simplex Well
with
Soft Starter
Input/Output Wiring for Booster Station with Soft Starter
Input/Output Wiring
for
Simplex Well
with
Phase Conversion
POWER DISTRIBUTION THIS PAGE REFLECTS "LOGICAL" SCHEMATIC SEE "DC DISTRIBUTION" DRAWING AND "AC DISTRIBUTION" DRAWING FOR POINT TO POINT TERMINATIONS
Input/Output Wiring
for
Grundfos BoosterpaQ
TP 6.0 Starter Panel

TP 6.1 Description of Operation

The function of the starter panel shall be to engage the power circuit to the motor and provide motor protection. The motor protection includes overcurrent, overload and phase loss.

The motor rating and available power shall govern the selection of one of the three starter panel designs. The two designs reflect the available distribution power and motor rating. In general, a magnetic starter shall be used on all single phase applications, a Square D Altistart 46 series soft starter shall be used for all three phase applications, and a Teco VFD shall be used for single phase to three phase conversion. In addition, a well site shall typically require a simplex starter design whereas a booster station shall require a duplex starter design.

An emergency H-O-A switch shall be located in all starter panels to override all motor control functions of the PLC control panel. The auto position allows the PLC control panel to control the motor. The off position disables any motor starter control functions. The hand position shall be a manual start setting for the starter.

A circuit breaker shall be provided for convenience and the system utilizes a common power ground.

TP 6.2 Simplex with Magnetic Starter

TP 6.2.1 Panel Materials and Components

1. Enclosure – Indoor Application
   MFG: Saginaw
   Model: SCE-36SA2610LPPL
   Backplane: SCE-36P24
   Size: 36 H x 26 W x 10 D
   NEMA: 12
   or
   MFG: Hoffman
   Model: A-36SA2610LPPL
   Backplane: A-36P24
   Size: 36 H x 26 W x 10 D
   NEMA: 12
   or
   Enclosure – Outdoor Application
   MFG: Saginaw
   Model: SCE-36HS3112LP
   Backplane: SCE-36P30
   Size: 36 H x 31 W x 12 D
   NEMA: 4

2. Disconnect
   MFG: Square D
3. Handle
MFG: Square D
Model: 9422-A1

4. Door Mount
MFG: Square D
Model: 9422

5. 240V Disconnect Fuse
MFG: Bussman
Model: FRN-R-40

6. Distribution Lugs
MFG: Square D
Model: LBA362104

7. Phase Loss Relay
MFG: Timemark
Model: 2681-240AC

8. 8 Pin Relay Base
MFG: Square D
Model: 8501NR51

9. Magnetic Starter
MFG: Square D
Model: 8536SDO1V02S

10. 15A Circuit Breaker
MFG: Square D
Model: QOU115

11. HOA Switch
MFG: Square D
Model: 9001KS43BH2

12. HOA Legend Plate
MFG: Phoenix Contact
Model: KN160WP

13. DPDT 110 AC Relay
MFG: Phoenix Contact
Model: UMK22-REL110

14. DPDT 24 DC Relay
MFG: Phoenix Contact
Model: UMK22-REL24

15. Master Relay
MFG: Square D
Model: CLASS 8501-TYPE X
XMO40V02

16. UK5 N Terminals
MFG: Phoenix Contact
Model: UK5 N

17. Ground Terminal
MFG: Phoenix Contact
Model: USLK5G

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TP 6.2.2 **Drawings** The standard drawing set shall include:

1. Cover Sheet
2. Logic Wiring
3. General Arrangement
NAVAJO TRIBAL UTILITY AUTHORITY
PUMP CONTROL PANEL LAYOUT

<table>
<thead>
<tr>
<th>SHEET</th>
<th>FILENAME</th>
<th>STYLE</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC_SM_ZV</td>
<td>ESSENTIAL</td>
<td>SCHEDULE OF DRAWINGS</td>
</tr>
<tr>
<td>2</td>
<td>NC_SM_L03</td>
<td>JOINT WRITING</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>NC_SM_SP</td>
<td>SD ARRANGEMENT</td>
<td>LAYOUT</td>
</tr>
</tbody>
</table>

MAG START PANEL
TP 6.4 Simplex with Soft Starter

The Square D Altistart 48 series starter requires an altitude derating. The derating shall apply to all locations conforming to the manufacturer’s recommendation.

The required interface wiring between the control panel and the starter panel shall be a minimum of nine I/Os. Of the nine I/Os, six are wired to the starter.

TP 6.4.1 Panel Materials and Components

The following panel materials and component listing shall be for a 60 HP starter for a 50 HP application. The panel fabricator shall review and select the appropriate materials and components for the motor rating.

1. Enclosure – Indoor Application
   - MFG: Saginaw
   - Model: SCE-36SA2610LPPL
   - Backplane: SCE-36P24
   - Size: 36 H x 26 W x 10 D
   - NEMA: 12
   or
   - Enclosure
     - MFG: Hoffman
     - Model: A-36SA2610LPPL
     - Backplane: A-36P24
     - Size: 36 H x 26 W x 10 D
     - NEMA: 12
   or
   - Enclosure – Outdoor Application
     - MFG: Saginaw
     - Model: SCE-36HS3112LP
     - Backplane: SCE-36P30
     - Size: 36 H x 31 W x 12 D
     - NEMA: 4

2. Disconnect
   - MFG: Square D
   - Model: 9422T_F___

3. Handle
   - MFG: Square D
   - Model: 9422-A1

4. Door Mount
   - MFG: Square D
   - Model: 9422

5. 480V Disconnect Fuse
   - MFG: Bussman
   - Model: FRS-R-___

6. 1/4A Class CC Fuse
   - MFG: Bussman
   - Model: KTK-R-1/4
7. Altistart 48 Soft Starter  
   MFG: Square D  
   Model: ATS48D__Y
8. 15A Circuit Breaker  
   MFG: Square D  
   Model: QOU115
9. HOA Switch  
   MFG: Square D  
   Model: K9001KS43BH2
10. HOA Legend Plate  
    MFG: Square D  
    Model: KN160WP
11. DPDT 24 DC Relay  
    MFG: Phoenix Contact  
    MODEL: UMK22-REL24
12. Master Relay  
    MFG: Square D  
    Model: CLASS 8501-TYPE X  
    XMO40V02
13. UK5 N Terminals  
    MFG: Phoenix Contact  
    Model: UK5 N
14. Ground Terminal  
    MFG: Phoenix Contact  
    Model: USLKG5

TP 6.4.2 Drawings  The standard drawing set shall include:

1. Cover Sheet  
2. Logic Wiring  
3. General Arrangement (7.5 to 50 HP, 60 and 75 HP or 100 HP)
NAVAJO TRIBAL UTILITY AUTHORITY
PUMP CONTROL PANEL LAYOUT

SOFT START PUMP PANEL
Soft Starter Pump Panel

7.5 HP to 50 HP Applications
Soft Starter Pump Panel

60 HP to 100 HP Applications
**TP 6.6 Simplex with Phase Converter**

The Teco GA7200 series VFD requires an altitude derating. The derating shall apply to all locations conforming to the manufacturer’s recommendation.

The required interface wiring between the control panel and the starter panel shall be a minimum of nine I/Os. Of the nine I/Os, six are wired to the starter.

**TP 6.6.1 Panel Materials and Components**

The following panel materials and component listing shall be for a 60 HP starter for a 50 HP application. The panel fabricator shall review and select the appropriate materials and components for the motor rating.

1. **Enclosure**
   MFG: Saginaw
   Model: SCE-72XM4018
   Backplane: 60 x 33.75 (included)
   Size: 72 H x 40 W x 18 D
   NEMA: 12
2. **Disconnect**
   MFG: Square D
   Model: 9422T_F___
3. **Handle**
   MFG: Square D
   Model: 9422-A1
4. **Door Mount**
   MFG: Square D
   Model: 9422
5. **480V Disconnect Fuse**
   MFG: Bussman
   Model: FRS-R-___
6. **Line Reactor**
   MFG: MTE Corporation
   Model: RL-___ 12
7. **Load Reactor**
   MFG: MTE Corporation
   Model: RL-___ 13C
8. **Cooling Fan**
   MFG: Hammond
   Model: PF 6000
9. **Intake Louver/Filter Kit**
   MFG: Hammond
   Model: PFA 5000
10. **VFD**
    MFG: Teco - Westinghouse
    Model: GA 7200 _____ N1
11. **15A Circuit Breaker**
    MFG: Square D
12. HOA Switch
   MFG: Square D
   MODEL: K9001
13. DPDT 24 VDC Relay
   MFG: Phoenix Contact
   Model: UMK22-REL24
14. UK5 N Terminals
   MFG: Phoenix Contact
   Model: UK5 N
15. Ground Terminal
   MFG: Phoenix Contact
   Model: USLKG5

**TP 6.6.2 Drawings** The standard drawing set shall include:

1. Cover Sheet
2. Logic Wiring
3. General Arrangement (7.5 to 50 HP, 60 and 75 HP or 100 HP)
NAVAJO TRIBAL UTILITY AUTHORITY
PUMP CONTROL PANEL LAYOUT

3 PHASE CONVERSION PUMP PANEL
TP 7.0 Appendix

TP 7.1 **Conductor Color Code** The conductor color code for all panel wiring shall be as follows:

<table>
<thead>
<tr>
<th>Service</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 VDC (HOT)</td>
<td>Violet</td>
</tr>
<tr>
<td>24 VDC (SWITCHED)</td>
<td>Blue</td>
</tr>
<tr>
<td>24 VDC (COMMON)</td>
<td>Brown</td>
</tr>
<tr>
<td>120 VAC (HOT)</td>
<td>Black</td>
</tr>
<tr>
<td>120 VAC (SWITCHED)</td>
<td>Red</td>
</tr>
<tr>
<td>120 VAC (NEUTRAL)</td>
<td>White</td>
</tr>
<tr>
<td>GROUNDING WIRE</td>
<td>Green</td>
</tr>
<tr>
<td>120 VAC (Foreign Source)</td>
<td>Yellow with Identifier</td>
</tr>
<tr>
<td>4-20 mA Pair (-)</td>
<td>Black</td>
</tr>
<tr>
<td>4-20 mA Pair (+)</td>
<td>White</td>
</tr>
</tbody>
</table>
TP 7.2 PLC Control Panel Test Sheet

Control Panel Test - Location:__________________  
Test Date:__________________

1. **Physical Test:**

   List any discrepancies with respect to the panel specifications:

   A. Dimensions, component layout and wiring specifications.

   B. Panel and component hardware.

   C. Quality of Workmanship (wiring and general panel assembly).

   D. Inventory of all panel parts and documentation (operations and maintenance manual).

2. **Functional Test:**

<table>
<thead>
<tr>
<th>DI</th>
<th>DO</th>
<th>AI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>LOOP POWERED</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>LOOP POWERED</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>SELF POWERED</td>
</tr>
<tr>
<td>4</td>
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<tr>
<td>9</td>
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<td></td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>24 VDC POWER</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
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<td></td>
<td>PS FAILRELAY</td>
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<tr>
<td>14</td>
<td></td>
<td>GFI</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>RADIO POWER</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>PANEL MATE</td>
</tr>
</tbody>
</table>

Comments:________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

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TP 7.3 Starter Panel Test Sheet

Starter Panel Test - Location:__________________
Test Date:______________

1. Physical Test:

List any discrepancies with respect to the panel specifications:

A. Dimensions, component layout and wiring specifications.
B. Panel and component hardware.
C. Quality of Workmanship (wiring and general panel assembly).
D. Inventory of all panel parts and documentation (operations and maintenance manual).

2. Functional Test:

<table>
<thead>
<tr>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disconnect Switch</td>
</tr>
<tr>
<td>HOA Switch - Auto</td>
</tr>
<tr>
<td>HOA Switch - Off</td>
</tr>
<tr>
<td>HOA Switch - Hand</td>
</tr>
</tbody>
</table>

Comments:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
TP 7.4 Radio Test Sheet

Test Location:__________________
Test Date:______________

Radio Model Number = _______________

1. Reflected power = _______________

2. Radio System Address = _______________

3. RSSI reading (Remote) = _______________

4. Mode = _______________

5. Long Polling (master), Buff = OnData

6. Interface Parameters:
   Baud Rate = ________
   Data Bits = ________
   Parity = ________

7. Quality of Workmanship - Antenna/Cable assembly

Comments:

________________________________________
________________________________________
________________________________________
________________________________________

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TP 7.5 Transducer Form

Tank: ______________________

Height: ____________________

Date: ______________________

The Ametek 88C pressure transducer shall be calibrated such that the height of the tank plus \( \Delta y \) equals 20mA and the base of the tank (\( \Delta y \)) equals 4mA.

ACTUAL TANK DATA:  

Tank Height = ___ ft  

TRANSUDCER DATA:  

Tank Height + \( \Delta y \) = ___ ft (20 mA)

\( \Delta y = ___ \) ft (4 mA)

0.0' (at base of transducer)

When ordering the Ametek 88C pressure transducer, specify the model and the calibration range. For example, say the tank height is 24 feet and \( \Delta y \) is 2.5 feet, the order will specify: Model #: 88C002A2 (calibrate 2.5 feet H\(_2\)O @ 4mA to 26.5 feet H\(_2\)O @ 20mA).

Comments: ______________________________________________________

______________________________________________________________

______________________________________________________________

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TP 7-5

August 05
TP 8.0 Pumphouse Wiring

The Contractor will be responsible for providing and installing wire, conduit, load centers, and all other appurtenances as shown on the Pumphouse Layout Drawings and in accordance with the following:

1. Provide and install all necessary conduit for the electrical, control, and antenna cables, and string wiring within the conduit.
2. Provide and install designated 15 amp circuit breakers for both the PLC control panel and starter panel and string number 12 TW solid copper from the load center to the gutter tray.
3. Provide and install conduit from pitless unit with motor leads to the gutter box.
4. Provide and install additional field wiring for the high-pressure discharge, low suction pressure cut-off, well transducer and chemical pump wiring.
5. Provide and install 2-inch G.I. pipe or appropriate support equipment for the antenna.
6. Provide and install Times Microwave, LMR-400, Coax antenna cable.

The Pumphouse Layout Drawings show the general location and orientation of the conduit and appurtenances, however, the size of wire and conduit, the size of the load center, and the requirement and size of the transformer are dependent on the size of pump proposed for the well and the type of power available at the well site.
Pumphouse Wiring Layout